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VOL. CXLII.—No. 3683] LONDON: FRIDAY EVENING, AUGUST 13, 1926 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 27th August, 1926, for LOW-PRESSURE HOT WATER HEATING, &c., at the National Physical Laboratory, Teddington.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3069

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

1. 250 Pairs DISC WHEELS and AXLES.
2. 1012 Tons STEEL FISH BOLTS.
3. 2500 Tons STEEL DOG SPIKES.
4. 16,000 Tons STEEL BEARING PLATES for RAILS.
5. 1500 SIGNAL LAMPS.
6. 188 Pairs of DISC WHEELS and AXLES.
7. 38 LOW-SIDED BOGIE WAGONS, 5 TIMBER BOGIE WAGONS and 8 TANK WAGONS.

Tenders due on the 27th August, 1926, for No. 1, on the 1st September, 1926, for Nos. 2 to 4, on the 3rd September, 1926, for No. 5, and on the 7th September, 1926, for Nos. 6 and 7.

Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which is not returnable. 3115

Assistant Engineers (6) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 30 years of age, unmarried, must have passed the examination for A.M.I.C.E. or possess a degree in Civil Engineering recognised by the Institution as exempting from Parts "A" and "B" of the examination. They must have had proper technical training and preferably have had not less than two years' subsequent experience on large Engineering or Municipal Works. Candidates possessing other civil engineering qualifications may apply.—Applications should be made at once by letter, stating age, qualifications and experience, also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14485. 2984

Ordnance Factories, WOOLWICH.

ASSISTANT FOREMAN REQUIRED, who has had workshop training and subsequent experience in running water-tube boilers, turbines, and reciprocating engines with direct-current and high-tension alternating-current generators in a station of not less than 6000 K.W. capacity. Must be of good health and character and preferably an ex-Service man not over 27 years of age.

Range of pay, including Civil Service bonus (which varies with cost of living), at present level £4 12s. 10d. to £5 6s. 1d. per week.

Forms of application, which must be returned not later than 31st August, from CHIEF SUPERINTENDENT, Ordnance Factories, Royal Arsenal, Woolwich, S.E. 18. 3068

University of Birmingham.

DEPARTMENT OF METALLURGY.

"FERNEY" PROFESSOR: D. HANSON, D.Sc.
LECTURERS AND DEMONSTRATORS: T. G. BAMFORD, M.Sc.
HAROLD HARRIS, M.Sc.
T. HENRY TURNER, M.Sc.

THE SESSION 1926-27 COMMENCES ON OCTOBER 4th, 1926.

The Course of Study covers three years and leads to the Degree of B.Sc. in Metallurgy. There are separate Courses for Metallurgists and Metallurgical Chemists. There is also an Honours School. Special attention is devoted to Iron and Steel, Copper, Brass, Metallography, the needs of local industries and to preparation for colonial and foreign posts.

Research and other Scholarships.

For particulars apply to the REGISTRAR. 2944

UNIVERSITY OF LONDON.

King's College.

FACULTY OF ENGINEERING.

COMPLETE COURSES of STUDY, extending over either three or four years, are arranged in CIVIL, MECHANICAL and ELECTRICAL ENGINEERING for the Engineering Degrees of the University of London and for the Diploma and Certificate of the College.

The four years' Course provides, in addition to the academic training, opportunity for practical training in "Works."

HEADS OF DEPARTMENTS.

Professor G. COOK, D.Sc., M.I. Mech. E., A.M. Inst. C.E., Mechanical Engineering.

C. A. GENEVE, B.Sc., A.M.I. Mech. E., Senior Lecturer.

Professor A. H. JAMESON, M.Sc., M. Inst. C.E., Civil Engineering (Dean).

C. H. LOBBAN, D.Sc., A.M. Inst. C.E., Senior Lecturer.

Professor E. WILSON, M. Inst. C.E., M.I.E.E., Electrical Engineering.

F. S. ROBERTSON, M.I.E.E., Lecturer.

Professor S. A. F. WHITE, M.A. } Mathematics,
Professor A. E. JOLLIFFE, M.A. }

Considerable extensions have been made in the Engineering Department. These include a large additional drawing-office, lecture room and laboratory for Hydraulics and Strength of Materials in the Civil and Mechanical Departments, and research rooms, including Wireless Telegraphy, in the Electrical Engineering Department. Large additions have been made to the equipment of the Laboratories in the three Departments for purposes of teaching and research.

There is a College Hostel and a large Athletic Ground.

For full information apply to the SECRETARY, King's College, Strand, W.C. 2. 2979

The Engineer

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PUBLIC NOTICES

EAST LONDON COLLEGE

(UNIVERSITY OF LONDON),
MILE END ROAD, E.1.

FACULTIES OF ARTS, SCIENCE AND ENGINEERING (CIVIL, MECHANICAL, ELECTRICAL AND AERONAUTICAL)

FACILITIES FOR RESEARCH.
PREPARATION FOR 1st M.B. EXAMINATION.
FEES £22 : 2 : 0 a year.
HOSTELS AND ATHLETIC GROUND.
NEW SESSION COMMENCES SEPT. 27.

Particulars, Post Free. E. J. WIGNALL, Registrar. 3036

University of Manchester.

FACULTY OF SCIENCE.

DEPARTMENTS OF CIVIL, MECHANICAL & ELECTRICAL ENGINEERING.

COMPLETE COURSES of STUDY, extending over three years, lead to the University Degree in Civil, Mechanical and Electrical Engineering. Students who have shown exceptional ability during the first year are admitted to the Honours Courses. The Session commences on the 7th Oct. A prospectus giving full particulars may be obtained on application to the REGISTRAR.

DEPARTMENTS.

Professor A. H. GIBSON, D.Sc., M. Inst. C.E., M.I. Mech. E. (Engineering).
Professor ROBERT BEATTIE, D.Sc. (Electrical Engineering).
Professor E. A. MILNE, M.A., F.R.S. (Applied Mathematics).
Professor L. J. MORDELL, B.A., M.Sc., F.R.S. (Pure Mathematics).
Professor ARTHUR LAPWORTH, D.Sc., LL.D., F.R.S. (Chemistry).
Professor E. ROBINSON, D.Sc., F.R.S. (Chemistry).
Professor W. L. BRAGG, M.A., F.R.S., Nobel Laureate (Physics).
Professor F. C. THOMPSON, B.Sc., D.Met. (Metallurgy).
Professor O. T. JONES, M.A., D.Sc., F.R.S. (Geology).

Students specialising in Water Supply and Irrigation, work under the direction of Associate-Professor E. SANDEMAN, M.Sc., M. Inst. C.E. 3078

PUBLIC NOTICES

University of Bristol.

FACULTY OF ENGINEERING.
(Provided and Maintained in the MERCHANT VENTURERS' TECHNICAL COLLEGE).

DEAN OF THE FACULTY:
ANDREW ROBERTSON, D.Sc., M.I. Mech. E., Assoc. M. Inst. C.E.

DEPARTMENTS.

CIVIL ENGINEERING—Prof. R. M. FERRIER, M.Sc., M. Inst. C.E., M.I. Mech. E.
MECHANICAL ENGINEERING—Prof. ANDREW ROBERTSON, D.Sc., M.I. Mech. E., Assoc. M. Inst. C.E.
ELECTRICAL ENGINEERING — Prof. DAVID ROBERTSON, D.Sc., M.I.E.E.
AUTOMOBILE ENGINEERING—Prof. W. MORGAN, B.Sc., M.I.A.E.
MATHEMATICS—Prof. E. S. BOULTON, M.A., B.Sc.
GEOLOGY—Prof. S. H. REYNOLDS, M.A., Sc.D.
CHEMISTRY—Prof. F. FRANCIS, D.Sc., Ph.D., F.I.C.

Complete Courses of Study extending over three years leading to the University Degree or Diploma in Civil, Mechanical, Electrical, or Automobile Engineering.

A Sandwich Scheme of Training extending over five years may be adopted by selected students.

Full particulars of courses and of the University Halls of Residence may be obtained on application to the REGISTRAR, M.V.T. College, Bristol.

The SESSION 1926-27 COMMENCES on OCTOBER 1st. 3020

Ely Urban District Council.

The Ely Urban District Council invite APPLICATIONS from fully competent persons, under 40 years of age and having the necessary technical and previous municipal or local government experience, for the combined APPOINTMENTS of SURVEYOR, INSPECTOR of NUISANCES and INSPECTOR of FACTORIES.

The person appointed will be required to devote his whole time to the services of the Council and will not be permitted to practise privately, and must reside in the city and carry out the duties now or hereafter appertaining to the above offices.

Office accommodation will be provided, together with stationery and other requisites.

The person appointed will be required to accept and act upon the professional advice and assistance of their present Surveyor, &c., Mr. W. McKelvie, C.E., whose services are being retained in an advisory capacity.

Applications, on forms which may be obtained of me, the undersigned, together with copies of three recent testimonials, must be sent so as to reach me, the undersigned, not later than Wednesday, the 1st day of September, 1926.

Canvassing will be considered a disqualification.

A. K. CAMPBELL,
Solicitor and Clerk to the Council.
Market-square, Ely, Cambs.,
10th August, 1926. 3111

PUBLIC NOTICES

University College of Swansea.

(A CONSTITUENT COLLEGE OF THE UNIVERSITY OF WALES).

APPLIED SCIENCE DEPARTMENTS.

ENGINEERING.

Professor: FREDERIC BACON, M.A. (Cantab.), A.M. Inst. C.E., M.I. Mech. E., M.I.E.E.
Lecturer in Electrical Engineering: R. G. ISAACS, M.Sc. (Bristol), B.Sc. (Lond.), A.M.I.E.E.
Lecturer in Civil Engineering: A. A. FORDHAM, B.Sc. (Lond.), A.M. Inst. C.E., M.I. Struct. E.
Assistant Lecturer: J. SELWYN CASWELL, A.M.I. Mech. E.

METALLURGY.

Professor: C. A. EDWARDS, D.Sc. (Manchester).
Lecturer: A. L. NORBURY, M.Sc. (Manchester).
Assistant Lecturers: L. B. PFEIL, M.Sc. (Lond.), A.R.S.M.
F. M. MACNAIR, Ph.D. (Sheffield), B.Sc. (Glasgow).

The College offers a number of exceptional advantages to Students who aim at entering upon professional careers in Engineering or in Metallurgy. It is situated in the heart of an industrial area, which includes a large number of works of very varied character, and presents an unrivalled variety of metallurgical practice. The manufacturers of the district, who contribute largely to the support of the College, give the Staff and Students of the Applied Science Departments every access to the works, and the Managers, Engineers, and Technical Officials co-operate with the Staff of the College in making visits to works of practical educational value to the Students.

Courses of study are provided (1) for the B.Sc. Degree of the University of Wales in (a) Civil Engineering, (b) Mechanical Engineering, (c) Electrical Engineering, (d) Metallurgy, and (2) for Diplomas of the College in (a) Civil Engineering, (b) Mechanical Engineering, (c) Electrical Engineering, (d) Metallurgy.

Persons who are not desirous of studying for Degrees or Diplomas may attend selected College Classes, provided they satisfy the authorities of the College that they are qualified to benefit by such Classes.

Entrance Scholarships will be offered for competition in September, 1926.

Particulars concerning admission to the College and of the Entrance Scholarships may be obtained from the undersigned.

EDWIN DREW,
Registrar.
Singleton Park, Swansea. 2923

Skegness Urban District COUNCIL.

WATERWORKS EXTENSIONS.
NEW WELL AND HEADING AT WELTON.

The Council invite TENDERS from competent well sinkers for the CONSTRUCTION of a 12ft. diameter WELL lined partly with Cast Iron Cylinders and partly with Brickwork and 125ft. deep; also a BRICK-LINED HEADING and other WORK connected therewith.

Copies of the form and conditions of contract, specification, form of Tender, schedule of prices and drawings can be obtained on application either to the Consulting Engineer, Mr. Percy Griffith, M. Inst. C.E., F.C.S., at 39, Victoria-street, Westminster, S.W. 1, or to the Council's Engineer and Surveyor, Mr. E. H. Jenkins, M.M. and C.E., Council Offices, Skegness, on deposit of a cheque for £5, which will be refunded on receipt of a bona fide Tender and the return of all documents supplied.

Tenders, on the form provided, duly sealed and endorsed "Tender for Well and Heading," must be delivered to the undersigned not later than Twelve Noon on Monday, the 13th day of September, 1926.

The Council do not bind themselves to accept the lowest or any Tender.

WILLIAM FREARSON,
Clerk to the Council.
Council Offices, Skegness. 3065

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. POINTS AND CROSSINGS.
2. STEEL BEARING PLATES.
3. FISH BOLTS, NUTS, &c.
4. MISCELLANEOUS ARTICLES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Points and Crossings," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 27th August, 1926.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of Specifications Nos. 1 and 2, and of 10s. for each copy of Specifications Nos. 3 and 4.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.
91, Petty France, S.W. 1,
10th August, 1926. 3103

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PUBLIC NOTICES

City of Birmingham Water DEPARTMENT.

ASSISTANT ENGINEER.

APPLICATIONS are INVITED by the Water Committee of the Corporation for the APPOINTMENT of ELAN SUPPLY RESIDENT ENGINEER, from Chartered Civil Engineers with knowledge and experience in the construction of gravitation water supply works, particularly of aqueduct construction.

The Engineer appointed may be required to live at or near Ludlow, Salop, to devote his whole time to the service of the Corporation, and to pass a medical examination, the appointment being subject to the provisions of the Local Government and Other Officers' Superannuation Act, 1922.

The commencing salary will be £500 per annum, inclusive of bonus.

A motor car and driver will be provided and maintained by the Department for the service of the Elan Supply Resident Engineer.

Applications, stating age and full details of training and experience and accompanied by six copies of not more than three recent testimonials, under cover, endorsed "Elan Supply Resident Engineer," to be sent to the undersigned not later than September 13th, 1926.

Canvassing will be regarded as a disqualification.

J. H. BROADLEY,
Secretary.

The Council House, Birmingham,
9th August, 1926. 3073

East Sussex County Mental HOSPITAL.

APPOINTMENT OF RESIDENT ENGINEER AND SURVEYOR.

The Visiting Committee invite APPLICATIONS from duly qualified candidates for the OFFICE of RESIDENT ENGINEER and SURVEYOR at the Mental Hospital, situate about half a mile from Hellingly Station on the Tunbridge Wells to Eastbourne Branch of the Southern Railway.

The Mental Hospital is lighted by Electricity, there is an Electric Tramway from the Hospital to the Railway Station, and the Hospital has its own Waterworks and Sewage Disposal Works.

The commencing salary will be £400 per annum, rising by £20 per annum to a maximum of £500 per annum, with unfurnished house (the Committee paying rates and taxes), electric light as fitted, water supply, vegetables and milk (estimated for purposes of superannuation at £140 per annum).

Candidates must not be less than 30 nor more than 45 years of age, and have thorough experience in the management of Boilers, Engines, Machinery, Electric Light Plant and Traction, Waterworks, Water Mains, &c., Sewage Disposal Works, the Care of Large Buildings, the control of workmen, be a competent Draughtsman and be able as part of his duties to Prepare Plans, Specifications and Estimates for New Buildings and the enlargement or alteration of existing ones.

The candidate will be required to devote his whole time to his duties and the appointment will be determinable by three months' notice on either side, terminating at any time.

Applications, on forms to be obtained from the undersigned, accompanied with copies of three recent testimonials (which will not be returned), to be sent to me, the undersigned, on or before the 6th day of September, 1926.

The candidate appointed will be required to enter upon his duties on the 1st day of November, 1926.

The salary (and emoluments) will be subject to deduction in respect of contributions under the Asylums Officers' Superannuation Act.

Canvassing members of the Committee will disqualify.

HAROLD M. BLAKER,
Clerk to the Visiting Committee.
211, High-street, Lewes, Sussex.
4th August, 1926. 3084

Sudan Government, Motor TRANSPORT SERVICE.

MECHANICAL ENGINEER REQUIRED, to Take Charge of Fleet of Motor Lorries, and must have had thorough training in their construction and maintenance. Age 25 to 35, single; good education. Commencing salary £E480 to £E540 per annum, according to age and qualifications. Strict medical examination. Free first-class passage. Progressive post if retained in the service. Liberal leave.—Apply by letter, giving full details of education, training and experience, to ADVISORY ENGINEER, Sudan Government, London Office, Wellington House, Buckingham-gate, S.W. 1, marking envelope "Mech. Engineer." 3098

THE DUTCH RAILWAYS AT UTRECHT

Will SELL by TENDER:

8 ELECTRIC LOCOMOTIVES, 180 H.P.

95 TIP WAGONS, with Wooden Box 5½ cub. meters,

45 STEEL SELF-DISCHARGING WAGONS, 5½ cub. meters

(1067 millimeters Gauge).

Kept in good repair and originating from earthworks at Arnhem (Holland), where the whole lot is being stocked.

Apply for further details to the

NEDERLANDSCHE SPOORWEGEN,
Dep: Weg en Werken N. UTRECHT.

Telegraphic Address: "Spoorwegen, Utrecht." 3077

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED for India, ENGINEER-SALESMAN. Good technical man, competent to handle contracts for power equipment of Textile Mills and Power Station Work. Will be attached to Indian Agents, headquarters Bombay. Previous Indian experience desirable, but not essential. Age 30-35. Good salary and commission. A man of good and strong character and a worker essential.—Apply, stating age, terms expected, with full particulars of past experience, to the MANAGING DIRECTOR, Hick, Hargreaves and Co., Ltd., Soho Ironworks, Bolton. 3084 A

A LARGE OIL COMPANY, Operating in Roumania, invite APPLICATIONS for POSITIONS in connection with Oilfield Engineering Work other than drilling. Essentials: sound technical training and completed apprenticeship with British engineering firm covering workshop and drawing-office experience.—Address by letter, giving full particulars, 3074, The Engineer Office. 3074 A

ASSISTANT ENGINEER REQUIRED, University training, engineering degree, and contractor's experience essential. Age not to exceed 28 years.—Apply in first instance in writing, stating age, full particulars of training and experience, to SECRETARY, Brunner, Mond and Co., Ltd., Northwich, Cheshire. 3106 A

ENGINEER DESIGNER.—APPOINTMENT is OPEN for MECHANICAL ENGINEER well versed in works practice and with good design experience, preferably including Chemical Plant and Machinery. Must be first-class mathematician; preference given to holder of Engineering Degree or Whitworth Scholarship. State full previous history and salary required.—Address, 3089, The Engineer Office. 3089 A

Autumn 1926

Leipzig Fair

The largest in the World:
11.000 Exhibitors from 21 Countries
160.000 Buyers from 44 Countries

Autumn Fair 1926:
29th August — 4th September

A visit will pay you!

For full particulars apply to:
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1, Gower Street, London W. C 1
166, Buchanan Street, Glasgow, C. 2
or to
The Leipziger Messamt, Leipzig, Markt 4

1148

SITUATIONS OPEN (continued)

REQUIRED for London Oil Burner Co., an ASSISTANT ENGINEER, with extensive knowledge, both theoretical and practical, of Oil Fuel Firing of Industrial Furnaces and Boilers. Must be competent to advise on own responsibility on all classes of heat treatment.

Engineering degree or equivalent essential.

Reply, stating age, education, oil experience and where obtained, fullest references, copies only photograph if possible, and salary required.

Applications not satisfying above requirements in full will not be considered.

Address, 3107, The Engineer Office. 3107 A

SERVICES REQUIRED.—ENGINEER, Regularly trained in Mechanical and Electrical Branches, as SENIOR for Department handling Plant and Machinery requirements for overseas trade. Commercial experience is essential, and applicants should have previously held positions fitting them to handle contracts from tender to shipment, inclusive of lay-out, purchase and inspection.

Give in strict confidence particulars age, experience, present salary and salary expected, to C. M., 64, Cannon-street, London, E.C. 4. 3067 A

THE PHŒNIX OIL and TRANSPORT CO., Ltd., operating in Roumania, has VACANCIES for a number of recent GRADUATES in the Faculties of Engineering, Mining, Civil or Mechanical, for POSITIONS as PROBATIONERS in OILFIELD ENGINEERING. It is essential that applicants should possess a B.Sc. Degree.—Particulars can be obtained from the Company's Offices, 9/13, Fenchurch-buildings, Fenchurch-street, London, E.C. 3. 3085 A

TRAVELLER WANTED for London and Suburbs (except S.W. 1 dist.), calling on users of Pneumatic and Suction Hose. Unique line in repeated demand, with great possibilities. Handsome commission. Exclusive representation to right man.—NEWTON SALES CO., Ltd., Charterhouse Chambers, E.C. 1. P2155 A

WANTED, Experienced RAILWAY CARRIAGE and WAGON DRAUGHTSMEN; must have considerable experience in both Wood and Steel Construction.—Apply by letter, stating experience and salary required, THE BIRMINGHAM RAILWAY CARRIAGE and WAGON CO., Ltd., Smethwick. 3109 A

DRAUGHTSMAN for Designing Department Constructional Engineers, Manchester district. Full details and references required with application.—Address, 3083, The Engineer Office. 3083 A

DRAUGHTSMAN REQUIRED, Experienced in the design of Water-tube Boilers and Accessories both for land and marine work. Applicants must give full details of past experience, stating age and salary expected.—Address, 3110, The Engineer Office. 3110 A

DRAUGHTSMAN REQUIRED for Gas Machines. One with Steel Works experience preferred. State fully qualifications, age and salary required.—Address, 3102, The Engineer Office. 3102 A

DRAUGHTSMAN WANTED by Engineering Firm for Jig and Tool Work for catalogue purposes. Must be a thoroughly practicable man.—Address, P2142, The Engineer Office. P2142 A

DRAUGHTSMAN WANTED in London, Thoroughly accustomed to detailing Structural Steel Work.—Address, giving age, particulars of experience, and salary required, 3094, The Engineer Office. 3094 A

EXPERIENCED DRAUGHTSMAN DESIGNER REQUIRED for Oil Extracting Presses and General Hydraulic Work. State age, experience, and salary required.—Address, 3113, The Engineer Office. 3113 A

EXPERIENCED LOCOMOTIVE DRAUGHTSMAN REQUIRED for large works. Capable of acting in supervisory capacity. Prospect of advancement and permanency for suitable man.—Address in strict confidence, stating age, experience, and salary expected, 3108, The Engineer Office. 3108 A

TRACER, Lady, Accustomed to Architectural and engineering details, for Engineer's Office ten miles N.W. London. State age, experience, and salary required.—Address, 3090, The Engineer Office. 3090 A

TWO First-class STRUCTURAL DRAUGHTSMEN REQUIRED for London. Must be conversant with requirements of L.C.C. Building Act for Steel-framed Buildings. Capable of surveying sites and be responsible for detailing of steel contracts in their entirety. Age, experience, salary required.—Address, 3076, The Engineer Office. 3076 A

SITUATIONS OPEN (continued)

A MILLWRIGHT REQUIRED, to Undertake Upkeep and Repairs for Small High-class Factory. Must be able to do Electrical, Water, and Mechanical Repairs.—Address, giving references, age, salary expected, &c., P2123, The Engineer Office. P2123 A

PLATER WANTED AT ONCE in Constructional Steel Work and Bridge Yard. Must be really first-class man, able to make his own templates. Permanency and good wages to suitable man.—Apply, stating previous employment and wages required, also send testimonials, to PRING and ST. HILL, Ltd., Constructional Engineers, Bedminster, Bristol. 3114 A

SITUATIONS WANTED

ADVERTISER DESIRES CHANGE, Engaged on experimental work. High-pressure steam, designs, inventions, press tools, and general engineering. London district preferred. Good ref.—Address, P2132, The Engineer Office. P2132 B

ADVERTISER, Having Wide and Unique Experience (English and continental) in mass production of precision work, general and electrical engineering, able to influence orders, DESIRES POSITION as General or Works Manager. Successful career in latter position. Proved organiser. First-class credentials.—Address, P2160, The Engineer Office. P2160 B

ADVERTISER, with Experience in Surveying, levelling, &c., WANTS POST with Contractor or Engineer. Single; go anywhere.—Address, P2153, The Engineer Office. P2153 B

ADVERTISER (24), Possessing Public School Education, B.A. degree (Cantab.), and over three years' practical training, consisting of about test bays, drawing-office and outdoor work, SEEKS a POSITION. Energetic and ambitious.—Address, P2130, The Engineer Office. P2130 B

APPOINTMENT DESIRED by Civil Engineer with wide experience abroad on railway survey, location, construction and management. Highest credentials.—Address, P2152, The Engineer Office. P2152 B

CHIEF ENGINEER, Age 40, DESIRES ENGAGEMENT; specialist in upkeep of factory plants, production and machine tools, or manufacture of general engineering work, supervision of erection of complete installations. Home or abroad.—Address, P2147, The Engineer Office. P2147 B

ENGINEER (30), Public School, Engineering College and apprenticeship training, works and commercial experience, SEEKS CHANGE, home or abroad. Responsible position with prospects. Ex-Service, loyal and efficient.—Address, P2150, The Engineer Office. P2150 B

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

French Naval Manœuvres.

The naval manœuvres which were carried out off the French coast during the past week were particularly interesting in view of the considerable part played by aeroplanes in resisting the landing of hostile forces. On the first day the squadron passed successfully through a minefield and repelled the attacks of submarines and landed troops at Cette. A dirigible which had been in observation aroused the air forces along the coast, and all through the second day aeroplanes attacked the landing forces with machine guns and bombs, but their operations failed to be entirely effective on account of the devastating work of seaplanes from the squadron. The fire from the warships prevented the defensive forces from deploying. The landing was, therefore, declared to have been carried out successfully. On the third day the landing forces attempted to consolidate their positions in face of the home defence, and here again aircraft played a leading part. The final result will probably be to impress upon the French the necessity of increasing still further the military and naval branches of the air force.

Electrification on the Southern Railway.

On Tuesday last the Southern Railway Company announced its intention to extend electric working in the South London area. The lines comprise the whole of the old London, Brighton and South Coast suburban area, with a small portion of the South-Eastern line. The scheme includes the equipping of the 127 single-track miles of the existing overhead electric system with the direct-current third rail as used on the other lines of the Southern Railway, together with the laying down of the third rail over 105 single-track miles of railway at present worked by steam—a total of 232 track miles altogether, exclusive of sidings. The total cost of the work will be £3,750,000. For a time the overhead electric construction will remain and trains will be worked by it concurrently with and over the same track as trains worked on the third-rail system, but ultimately the overhead equipment will be eliminated and all trains will be worked on the third-rail system, thus standardising for all three sections of the Southern Railway the suburban train equipment, track, &c. The lines affected comprise services by steam trains at present totalling 2,038,556 train miles per annum and by single-phase trains totalling 2,377,973, or a total mileage of 4,416,529. The proposed new "all-electric" services will give an annual train mileage of 7,636,000, which is equivalent to 100 per cent. increase in the case of the present steam mileage and 50 per cent. in the case of the present electric mileage. The work will, it is hoped, be finished by the end of 1928.

The Clyde Turbine Steamer King George V.

The new high-pressure turbine steamer King George V., which has been built by William Denny and Brothers, Ltd., of Dumbarton, for the Clyde passenger service of Turbine Steamships (Glasgow), Ltd.—John Williamson and Co., managers—began on Friday last a series of trials on the Firth of Clyde. The new steamer is a vessel of 750 gross tons, and she is engined with twin-screw high-pressure turbine machinery of about 3500 indicated horse-power, designed and built by the Parsons Marine Steam Turbine Company, Ltd., of Wallsend-on-Tyne. Her coal-fired boilers, which work at the high pressure of 550 lb. per square inch, were constructed by Yarrow and Co., Ltd., of Scotstoun. They were described and illustrated in our issue of April 9th. The King George was launched from Messrs. Denny's yard in April last, and by about the end of last month the machinery was installed. Since the recently ended Glasgow Fair holidays the vessel has been moored at Messrs. Scott's fitting-out basin at Greenock. After successful accumulated steam safety valve trials at a pressure of 575 lb. per square inch, which were followed by basin trials last week, preliminary speed trials on the Firth of Clyde were begun. The performance of the vessel and her machinery will be awaited with considerable interest by marine engineers and shipbuilders. It is confidently expected that, like her precursor the King Edward of 1901, the boat will mark the beginning of a new era in marine steam turbine and high-pressure boiler practice.

An Industrial Relations Delegation.

Some time ago it was announced that the Government had decided to send a delegation to Canada and the United States of America for the purpose of studying industrial relations in those countries, with special reference to the relations between employers and employed, and their bearing upon industrial relations in our own country. The Ministry of Labour now announces the names of the seven members of the delegation, which, it is expected, will leave this country in the early autumn. The chairman of the delegation will be Sir William Mackenzie, late President of the Industrial Court and Chairman of the Railway National Wages Board; industry is represented by Mr. Michael B. Dewar, who is the managing director of the Metropolitan Carriage, Wagon and Finance Company, Ltd., and is also associated with a number of other engineering companies, and Mr. Charles Randolph Smith, a director of Barclay, Curle and Co., Ltd., and late managing director of the North British Diesel Engine Works (1922), Ltd., which has now been taken over by Barclay, Curle. Trade union interests are represented by Mr. Ernest Bevin, the general secretary of the Transport and General Workers' Union, and Mr. J. Kaylor, a member of the Executive Council of the Amalgamated Engineering Union. The Ministry of Labour lends two members of its staff to the delegation, Mr. F. W. Legget, the Assistant Secretary in the Industrial Relations Department, and Mr. I. Haig Mitchell, its principal conciliation officer.

An Unusual Railway Accident.

A very unusual railway accident took place not far from the Central Station, Newcastle, at 11.50 p.m. on Saturday evening, when an express electric train from Whitley Bay to Newcastle collided with a goods train at East Manors Station. Two of the coaches of the electric train were telescoped and several trucks near the centre of the goods train, which was crossing the line at the moment, were smashed. Only five persons were injured, but subsequent investigation resulted in the finding of the driver of the electric train dead on the 6ft. way near the Heaton-road bridge, some two miles from the place of the accident. It is surmised that the driver was looking out of the cabin window and was struck by the pillars of the bridge, which threw him from his cabin. The train then continued to run on at a speed of about 40 miles per hour until it met the goods train at East Manors Station. After carefully examining the motorman's compartment the L.N.E.R. authorities issued on Monday last a statement to the effect that the safety control known as the "dead man's handle" had been tampered with by fastening down the stud in the handle so that it could not automatically act to cut off the current. The manner in which that was done and for what purpose the device was interfered with will, naturally, be investigated during the Ministry of Transport inquiry into the accident, which was begun in Newcastle yesterday.

A New Dublin Service Tunnel.

During the past week work was begun on the Liffey tunnel, which will carry service mains under the river from the north to the south of Dublin. The tunnel will have a length of 271 yards, and will run from the North Wall Extension to the end of Tarn-castle-street, Ringsend. At each of these points a shaft will be sunk in the limestone rock to a depth of about 100ft., and a connecting tunnel driven under the river. The tunnel, which is to have a finished internal diameter of 7ft., will be lined with 6in. reinforced concrete segments. Cast iron segments will be employed for lining the two shafts, and the segments will be backed with cement grout and covered with a thickness of 10in. of concrete. Pumping operations will be necessary for the work, and if much water is encountered use will be made of a special quick-setting cement. When the tunnel has been completed a 24in. water main and a sewage main will be laid through it, as well as high-pressure electric supply cables from the Pigeon House power station for new industrial developments in the north of the city. The proposal to make a footpath for pedestrian traffic through the tunnel has had to be abandoned, on account of the expense entailed; but the need of better cross-river transport at this part of the city is widely felt, and it has been suggested that a new bridge over the Liffey should be constructed in the locality.

The New Master Cutler.

At the annual meeting of the Cutlers' Company of Hallamshire, which was held on Tuesday, the 10th inst., Mr. David Flather was elected the new Master Cutler, in succession to Mr. T. R. Ellin. The new Master will take up his duties after his installation, which ceremony is fixed for Tuesday, October 5th. Mr. Flather was born in 1864 and he received his education at the Sheffield Collegiate School and Firth's College. In 1880 he entered the service of John Brown and Co., Ltd., as a metallurgical chemist, and six years later he joined his father's firm of W. T. Flather, Ltd., of which he subsequently became the managing director. The firm was originally founded in Solly-street in the year 1817 by David Flather the elder, Mr. Flather's grandfather; later the business was extended by the acquisition of the Love-street Steel Works. As early as 1886 the firm interested itself in the manufacture of special steels for cycle construction and also in the production of bright drawn steels. In this connection the subject of case-hardening steels was studied, and the new practice, involving the use of case-hardening steels, which has since become a standard, was perfected about 1901. The early experience which was gained by the firm in meeting the requirements of the cycle trade enabled it to cope successfully with the more stringent demands of the motor industry. In 1912 a new works was built, and in February, 1913, work was started at the Standard Steel Works, Tinsley, which has since that time been largely extended, particularly as regards the bright drawn steel departments. It is of interest to record that the new Master Cutler was a member of the original committee of five Sheffield metallurgists which drew up, under the auspices of the Institution of Automobile Engineers, the series of specifications for special alloy steels, which have since come to be regarded as standard specifications for that industry.

The Shipbuilding Trades Investigation.

It is understood that the representatives of the shipyard trade unions will shortly resume consideration of the report of the Joint Committee of Inquiry into the subject of foreign competition and conditions in the shipbuilding industry, which has already been referred to in our issue of June 25th, 1926. The matters which are likely to be discussed will include the proposals embodied in the first part of the report regarding the greater interchangeability of labour and the relaxation of existing demarcation practices. The extension of the system of payment by results and the recommendations of the Joint Inquiry Committee regarding the use of labour-aiding machinery will also be considered,. It will be recalled that the report called attention to the duty of all parties to secure for the whole of the shipbuilding industry such savings in cost as can be obtained by the use of labour-aiding machinery and other methods which would enable the fullest output to be obtained.

Mishap to Submarine H 29.

On Monday last the submarine H 29, which was undergoing refit at Devonport Dockyard, foundered in the basin while a number of dockyard workmen were on board. The majority of them had time to get ashore, and others who were thrown into the basin when the vessel heeled over were rescued. Unfortunately, however, Chief Engine-room Artificer R. W. Dalton and five workmen who were below at the time are reported to have lost their lives. The cause of the accident remains a mystery for the present, but from the fact that the boat went down in less than two minutes, it is evident that the inrush of water must have been very great. Earlier in the day the H 29 had been subjected to stability trials, and it is surmised that the weight of water remaining in the after ballast tanks caused the mooring ropes at the bow to part under the strain. A very gallant effort was made by Lieut. M. E. Wevell, R.N., to save the lives of the men below. When the boat began to sink he tried to close the watertight doors, but before that could be done, the volume of water swept him through the conning-tower hatch, rendering him unconscious. He was fortunately seen and rescued. The submarines of the "H" class, of which twenty remain in the Navy, are British adaptations of an American design which was evolved during the war. They have an excellent reputation for safety and handiness. The H 29, laid down by Vickers Ltd. in 1917, is a boat of 440 tons surface displacement, with engines developing 480 brake horse-power for surface propulsion. The complement numbers twenty-two. A sister boat, the H 42, was sunk with all hands in collision with a destroyer in March, 1922.

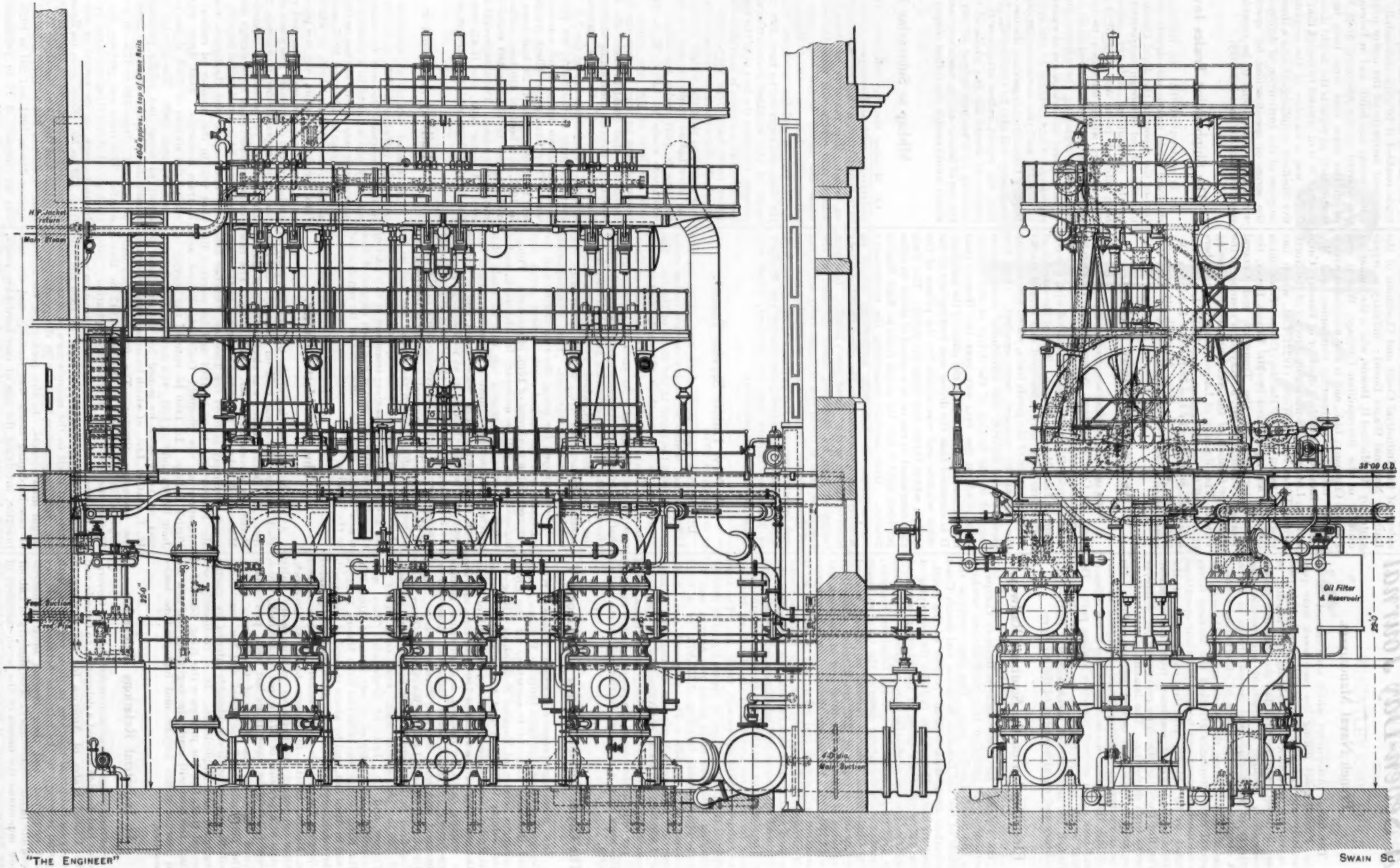
Railway Accidents in 1925.

The annual returns of accidents and casualties on British railways in 1925, issued on Friday last, are in many respects the best for many years. There was only one accident to a passenger train in which a passenger was killed, so that in that respect it was as good a year as 1909 and 1917, and almost as good as the years 1901 and 1908, in which there were no fatal accidents. Again, only one passenger was killed in a train accident last year, and since 1843 that, excluding the completely free years of 1901 and 1908, had only happened once previously, namely, in 1909. The number of passengers injured—391—was the lowest recorded since 1908, except perhaps during the war years when no detailed reports were made. In only one respect were the figures unsatisfactory, and that was in the number of railway servants killed in train accidents. That figure was fourteen, and, except the sixteen of 1909, it has not been so high since the year 1900. The number of collisions was about as usual, but whilst passenger train derailments showed little difference, there was a drop of 50 per cent.—from 346 to 173—in goods train derailments. This drop was perhaps due to a change in the method of reporting employed by the London and North-Eastern, as its record in this connection fell from 239 to 80. Even now, its figure compares unfavourably with the 44 of the London, Midland and Scottish and the 28 of the Great Western. In movement accidents 242 railway servants were killed, as against 220 in 1924 and 201 in 1923, of which there was an increase of 16 in permanent way men as compared with 1924.

VERTICAL TRIPLE-EXPANSION PUMPING ENGINE AT WALTON-ON-THAMES

HATHORN, DAVEY AND CO., LTD., LEEDS, ENGINEERS

(For description see opposite page)



"THE ENGINEER" SWAIN Sc.

New Filtration Plant at Walton-on-Thames.

No. III.*

In our preceding articles we described the new primary and secondary filters at the Walton station of the Metropolitan Water Board, and traced the progress of the water through the works until it reached the pumping station. We give in what follows a description of the new machinery which has been installed to deal with the filtered water, and of the extension to the original building which has been rendered necessary.

The late Sir J. W. Restler, when designing the original pumping station, provided for the increase of its capacity, and constructed the northern end wall so that it could readily be removed. The result of building-on the extension has been the creation of an exceptionally fine engine hall, which strongly reminds the visitor of a well-arranged machinery exhibition, an impression which is strengthened by the diversity of machines which are now at work, and by the strikingly excellent condition in which the whole of the plant is kept. It is hard to believe from their appearance or running that the older machines have been in operation for fifteen or sixteen years. The Water Board is, however, notorious—as were the old companies—for the care taken of its machinery. The illustration—Fig. 17—which is a view taken looking through the columns from the old part of the machinery building into the extension, gives a very good idea of the general appearance of the new portion of the hall. The original designer must, we think, have envisaged the excellent effect the building-on of an extension would have. In the original building the space between the two sets of central columns was occupied by a doorway with a large semi-circular window above it. Between each of the two sets of central columns and the corresponding columns near the wall was, originally, a tall rectangular window. All three windows have now, of course, been removed.

As originally built, the pumping station only contained low-lift pumps, since it was only called upon to raise water from an intake from the river Thames and deliver it into reservoirs near by. The total head against which the pumps had to work was only about 55ft. For dealing with the filtered water from the new works, it was necessary to provide machinery which could, when required to do so, operate against a head of nearly 260ft., and, consequently, the new pumps are found to differ radically from those originally installed. A very great deal of care was exercised in deciding upon the types of pumping machinery to employ, and the specification was only drawn up after extensive investigations and minute calculations had been made. As a result, it was decided to provide in the first instance two distinct types of pumps, namely, (*a*) a slow-speed vertical triple-expansion reciprocating engine, driving three single-acting compound plungers, consisting of an internal and an external portion, as will be explained later, and (*b*) a high-speed steam turbine driving through gearing two centrifugal pumps mounted on one shaft and designed to work in parallel.

The varying conditions under which these two units were required to operate were specified as follows:—

Reciprocating Unit.

	At maximum efficiency.	At maximum quantity.	At maximum P.H.P.
Million gallons per 24 hours	14·1	24	17·5
Total head in feet	236	139	257
Revolutions per minute ..	25	25	31
Portion of plunger working	Internal	Internal and external	Internal
Pump horse-power	700	700	945
Pump horse-power at 1 r.p.m.	28	28	30·5

Steam Turbine Unit.

	At maximum efficiency.	At maximum quantity.	At maximum head.	At minimum quantity.
Million gallons per 24 hours	17·5	23	17·5	17
Total head in feet	236	139	257	106
Number of pumps at work	2	2	2	1
Pump horse-power	868	670	945	380

It was estimated that, having regard to (*a*) the relative efficiencies of the two types of pump; (*b*) the relative first costs and running costs; and (*c*) the relative "lives" of the different units, and hence the relative periods in which the initial expenditure would have to be repaid, this combination of slow-speed vertical reciprocating and high-speed turbine plants would give the best ultimate financial result. It was realised, of course, that a slow-speed reciprocating installation would cost a great deal more, in the first place, than a high-speed turbine plant—from three to four times as much. But, on the other hand, its life would be a great deal longer, and its efficiency considerably higher, so that, not only could its initial cost be spread over a greater number of years, but it could also be run more economically. As it is intended to run the slow-speed plant practically continuously—at any rate for 95 per cent. of the whole time—it was insisted that its steam consumption must be specially low.

Space has been left in the engine-room for a further pumping unit, if and when it becomes necessary to install it; but, as a matter of fact, we believe that it has not yet been decided which type will be chosen. It will depend on the actual results reached in practice. As at present arranged, there is sufficient room to erect a second high-speed unit without making any change in the arrangement of the existing plant. Should it be decided, however, to put in a second low-speed unit, the turbine pump will have to be moved

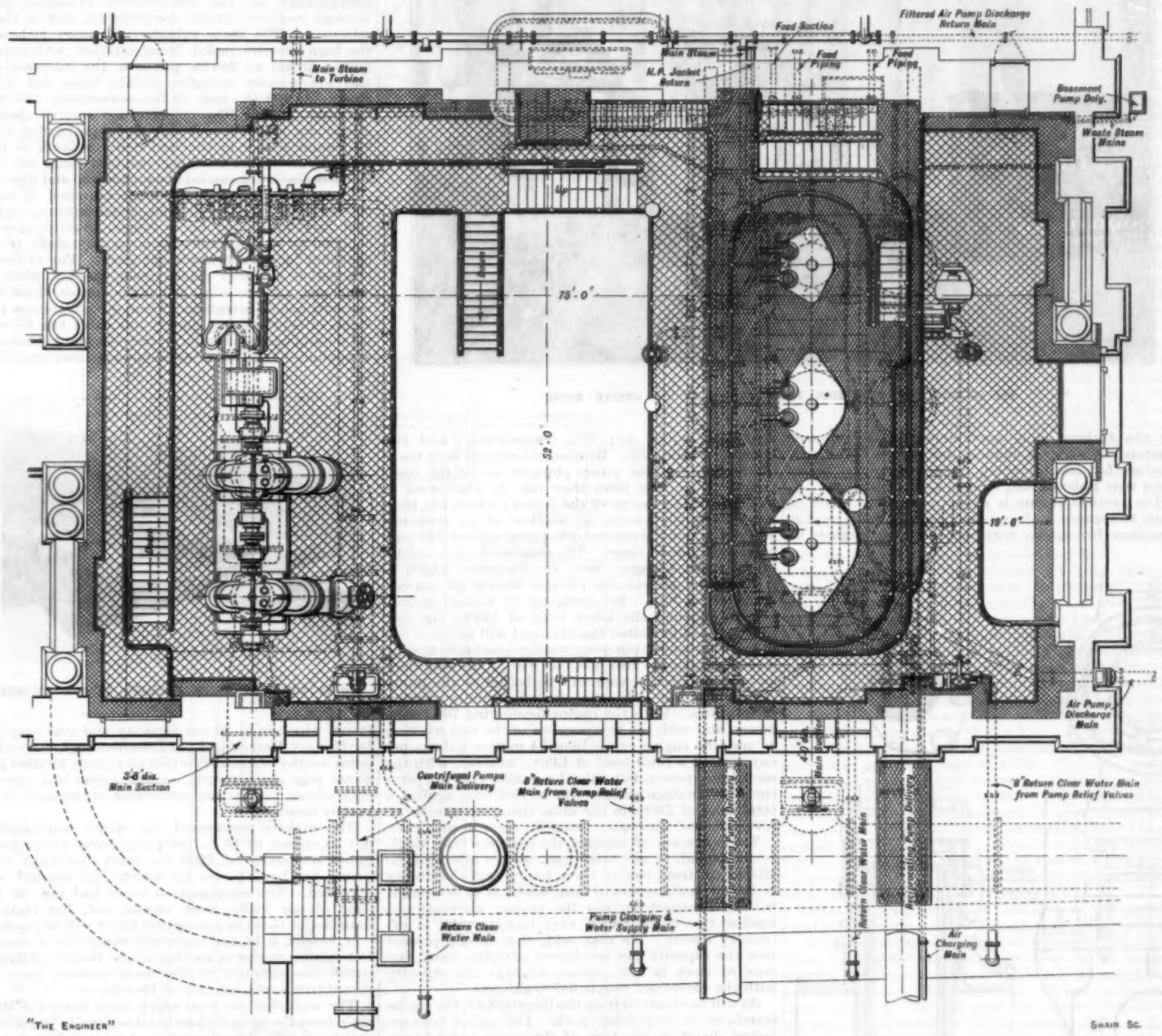


FIG. 16—PLAN SHOWING POSITIONS OF NEW PUMPING UNITS AT WALTON PUMPING STATION

* No. II. appeared August 6th.

into an annexe, and, for that possibility, provision has, so we understand, been made. A plan of the new part of the station is given in Fig. 16.

The result of putting out the machinery to tender was that the contract to supply the whole of it was awarded to Hathorn, Davey and Co., Ltd., of Leeds, which firm itself built the reciprocating unit, while

FIG. 17—VIEW OF EXTENSION FROM OLD PART OF ENGINE-ROOM

for the turbine unit there were various sub-contractors, as we shall show in due course. The contractors for the necessary extension to the boiler plant were Babcock and Wilcox, Ltd., of London.

The vertical engine is an extremely fine piece of work as regards both construction and finish, and it compares favourably with any pumping engines of

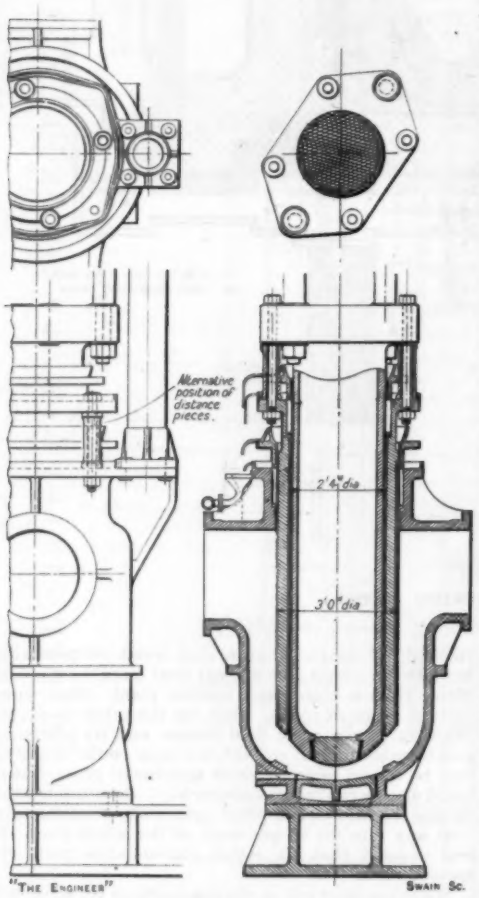


FIG. 18—COMPOUND PUMP RAM

its type that we have seen. It has been built to the designs of the Water Board's engineers, the contractor in this instance not having been required to put forward his own design. As will be realised from the view of it which is given on page 172 and from the drawing which is reproduced on page 160, it is an extremely handsome engine, and it might well be termed majestic, since the extreme height from the pump-room floor to the tops of the cylinders is 52ft.

The general design is so clearly shown in the illustrations that no very detailed description is called for. The engine was designed for a working steam pressure of 200 lb. per square inch, and for a superheat of 100 deg. Fah. The diameters of the three cylinders are 25in., 47in., and 70in. respectively, and the common stroke is 5ft. Mention has already been made of the fact that the pump plungers are of the compound type. The form they take is illustrated in Fig. 18. It is a design of the Board's which has been employed with success at another of its pumping stations, where it is necessary to pump against different heads at different times. The rams at Walton consist of an inner plunger, 28in. in diameter, which is encircled by an annular plunger having an outside diameter of 36in. For pumping 24 million gallons per day against the lower head of 139ft., the two plungers will be bolted together and will move as one piece, whereas, for pumping smaller quantities against greater heads, the two portions will be disconnected, and the annular portion will be bolted to the pump casing, so that only the smaller-diameter portion reciprocates. With the engine developing 700 horse-power, and with the two portions of the ram working as one, the engine can deliver 24 million gallons per day against a total head of 139ft., whereas, with the same horse-power, but only the smaller ram in operation, 14·1 million gallons will be delivered against a total head of 236ft. in the same time, the number of revolutions of the engine being the same in each case.

The operation of altering the plungers from single to compound, or *vice versâ*, can, we are informed, be effected in from two to three hours, and the ability to have two diameters of ram, when, as at Walton, it will be necessary to run the engine, alternatively, against two heads which vary considerably, is extremely useful. We may add, that in the present case the capacity per revolution with the small ram only at work is 399 gallons, whereas the capacity with the compound ram is 659·6 gallons.

As will be observed from the illustrations, the engine stands on its own pump work. The engine beds are bolted direct to the tops of the pump valve-boxes, a construction which avoids the necessity for separate foundations, and greatly facilitates access to the pump work. Furthermore, no artificial light is required on the pump stage. Two steel girders, arranged longitudinally under the engine bed, span the engine-house from wall to wall, and their provision makes it possible for any one of the valve-boxes to be removed for repairs when necessary, the weight being ordinarily taken by means of double wedges.

The valves employed for the steam cylinders are of the Cole, Marchent and Morley piston drop valve type. They are worked by excentrics from a lay shaft in front of the cylinders and have variable expansion gear, that in the case of the high-pressure cylinder being controlled by a hand wheel adjacent to the main stop valve hand wheel. There is an emergency governor which operates by cutting off the steam and destroying the vacuum. It can be arranged to trip at any desired speed. It is, we understand, set to trip at a speed of 32 revolutions per minute, the ordinary running speed being 25 revolutions per minute. It is also arranged to operate should the pressure in the pumping main fall for any reason, such, for instance, as a fracture of the main, and it can also be operated by hand.

The crank shaft is 19½in. in diameter, and each of the four journals measures 16in. by 24in., the crank pins measuring 12in. by 10in. The two fly-wheels, which are 15ft. in diameter, each weigh 22 tons. Both can be used for barring; that on the right-hand side in the engraving on page 172 having internal teeth which can be engaged by a pawl operated by a long hand lever, and that on the left-hand side having shrouded teeth on the rim which mesh with the driving pinion of an electrically operated Musgrave barring engine. In this connection it may be remarked that in order to reduce steam losses to the fullest extent, as few steam-driven auxiliaries as possible have been employed. The feed, air and air-charging pumps are all driven off the main engine, while an auxiliary charging pump and a basement pump, as well as the barring engine, are all driven electrically.

The steam passing from the high-pressure cylinder on its way to the intermediate cylinder, and from the intermediate to the low-pressure cylinders, goes through receivers which are jacketed, and is there reheated. The three cylinders are also jacketed, the high-pressure jacket being supplied with superheated steam at 200 lb. pressure, the intermediate and low-pressure cylinder jackets being fed with steam at 100 lb. and 40 lb. respectively through reducing valves. The cylinder and receiver jacket drains are trapped, and the discharge carried to a feed-water heater in the feed delivery main in the boiler-house before reaching the feed tank, all oily steam drains being carried to a grease trap and filter.

Great care has evidently been exercised in connection with the lubricating arrangements, sight-feed lubricators, fed by a central gravity system supplied by a pump driven from the main shaft, being provided for all the important parts. For cylinder lubrication a pump driven from the lay shaft is employed. Accessibility is another matter which has received special attention. There are galleries at the levels of (*a*) the pump glands and valve box covers, (*b*) the engine cross heads, (*c*) the tops and bottoms of the cylinders, and for access to the overhead travelling

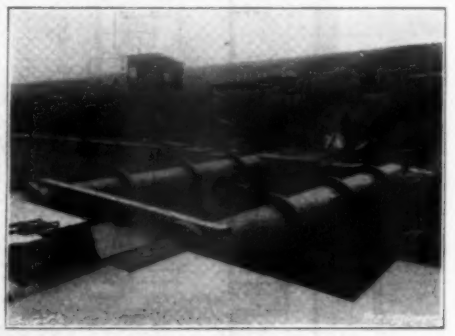


FIG. 19—DELIVERY PIPES CROSSING INTAKE CHANNEL

crane, which is of 20-ton capacity and was supplied by Herbert Morris, Ltd., of Loughborough. Another point worthy of mention is that accurately levelled gun metal pegs are arranged on the engine bed, one at each corner, so that any settlement of the bed can be readily detected.

The makers guaranteed the steam consumption not to exceed 10·85 lb. per pump horse-power hour, under a penalty of £200 for every one-tenth of a pound per horse-power by which that amount was exceeded. The consumption trials had not, at the time of our visits, been carried out, but there is little doubt that the guaranteed figure will be reached, —if, indeed, it be not improved upon—for a similar but smaller engine in another of the Board's stations, which was supplied by the same makers, gave on actual trial a consumption of 10·6 lb.

The main suction pipe which leads from the 60in. main from the suction chamber described in the second article, is 42in. in diameter, and from it branch two pump suctions, each 30in. in diameter. A condenser having 1500 square feet of cooling surface is arranged in the suction main, so that a separate circulating pump is not necessary. The pump valves are of the multi-disc rubber type. The total area furnished by all the suction valves is 32 square feet, and the rate of flow of the water through them is 2¼ft. per second when the engine is running at normal speed. Similarly, the total area of the delivery valves is 29 square feet, which gives a rate of flow of 3ft. per second. A 6in. diameter charging main controlled by a starting valve is connected to the pumping main for charging the pump barrels through non-return valves, which enables the engine to be started with ease against the static head in the rising main, and at the same time retains the air under pressure in the air vessels above the delivery valves. There are two delivery pipes, each 28in. in diameter, and they are led straight out of the engine-house and over the inlet channel to the further bank—see Fig. 19—where they are curved to connect with the 48in. pumping main, a large air vessel being arranged near the junction. The width of the flanges of the portions of the pipes crossing the intake channel was increased at the top and bottom, so that the whole flange is oval in shape, to give

HIGH-SPEED CENTRIFUGAL DUPLEX TURBINE PUMP

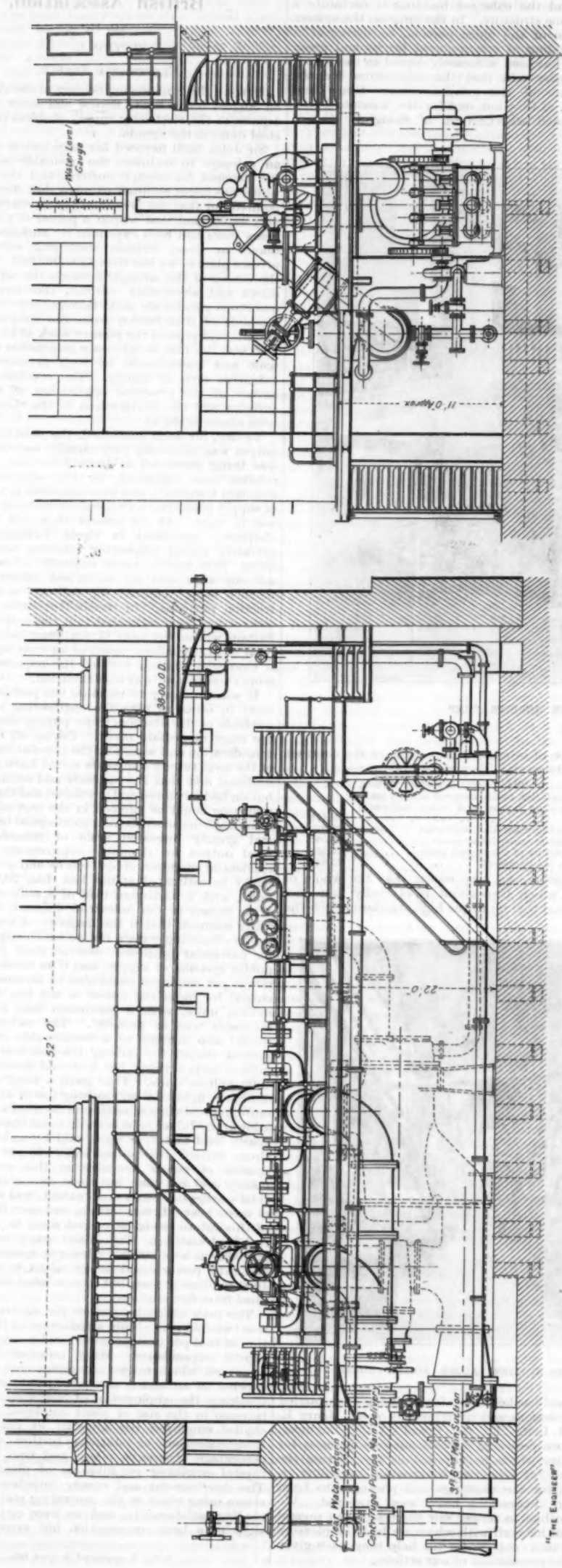


FIG. 20

additional strength to the joints. Just the other side of the intake channel there is, in each case, a telescopic length of pipe to facilitate connecting up with the pumping main, and the flanges of the two ends of this length are connected together by screwed bolts.

The auxiliary electrically-driven air compressor, already mentioned, which is designed to charge all the air vessels, is connected on the suction side, so that it can also be used for obtaining a vacuum in the main engine condenser before starting, and for charging the centrifugal pumps should the level of the filtered water be lower than usual, though normally the suction water level is above the pumps. All the water-pressure gauges are corrected to read from the engine-house floor level, so that the readings of the suction and delivery gauges together give the total head that the pumps are working against, and there is no need to use a constant. The delivery pressure gauges, which are in duplicate, are connected to each side of the non-return valve on the pumping main, while a special gauge, on which the pump-house power developed by the unit at work can be read off directly, has been fitted.

The turbine pump is a composite unit made up of the products of several firms. In the first place, there is the turbine itself, which was made by Belliss and Morcom, Ltd. It is a ten-stage impulse turbine with rotors 36in. in diameter, designed to develop its full power at 3700 revolutions per minute, with steam at 200 lb. pressure per square inch, and superheated 100 deg. Fah. It is fitted with a Worthington-Simpson condensing plant having steam air ejector pumps and an electrically-driven condensate pump. In addition, there is an alternate drive of the condensate pump by means of a water turbine worked off the main pump deliveries in case of failure of the electric supply. The gearing between the turbine and the pumps, which is designed to reduce the turbine speed of 3700 revolutions per minute to 1130 revolutions per minute of the turbine shaft, is of the single-reduction type, and was supplied by David Brown and Sons, Ltd., of Huddersfield. The two centrifugal pumps, which are mounted on the same shaft, with a clutch between them, so that one pump —that nearer the turbine—can be run without the other, were made by Mather and Platt, Ltd., of Manchester. They are of what is known as the Mediyane split-casing type, and each has a single impeller 26in. in diameter. The guaranteed consumption of this plant is 13·9 lb. of steam per pump horse-power per hour, with steam at 200 lb. pressure and 100 deg. Fah. of superheat, and it is subject to a penalty of £50 for each one-tenth of a pound by which that figure may be exceeded. The plant, like the reciprocating unit, has not yet undergone its efficiency trials.

The capacities of this turbine pumping unit, a view of which, taken from one of the platforms of the reciprocating engine, is given in Fig. 21—which illustration, incidentally, also shows a view looking along the engine-room in a direction opposite to that shown in Fig. 17—are as follows :—(*a*) With one pump working alone, 17 million gallons of water can be pumped per twenty-four hours against a head of 106ft.; (*b*) with the two pumps in operation 23 million gallons can be pumped in twenty-four hours against a head of 139ft.; or (*c*), also with the two pumps at work, 17½ million gallons can be pumped in the twenty-four hours against a head of 257ft. With one pump at work pumping 17 million gallons of water per day, the horse-power required is 380. With two pumps working together at maximum efficiency and pumping 17½ million gallons of water per twenty-four hours against 236ft. head, the horse-power absorbed is 868. The maximum horse-power which the set is designed to develop is 945. Drawings showing the arrangement of this pumping unit is given in Fig. 20.

The main governor of the turbine is of the centrifugal type, and it operates through an oil relay system to limit the variation of speed to within 2½ per cent. There is also an emergency governor which either automatically shuts off the steam when the speed has reached a certain limit above the normal or can be hand operated. As the governor control regulates the speed independently of the pressure head in the pumping main, there is an electric bell alarm which will ring should the pressure in that main fall below a prescribed limit. This bell is, of course, in addition to the automatic trip arrangement already mentioned. A Kent steam meter is fitted in the steam main.

The delivery pipe from the turbine plant, which is 21in. to 28in. in diameter, is led out of the engine-house and over the intake channel parallel with and in a manner similar to that employed for, the delivery mains from the vertical pumping unit. It also makes connection with the 48in. pumping main. A Venturi meter inserted in that main records the total water pumped by both units—the reciprocating and the turbine—and also the pressure in the main beyond the air vessel and a reflux valve. We may add that, on the occasion of the formal opening of the station, both pumping units were, in turn, put to work by Mr. Chamberlain by the turning of a small hand wheel, and that both started well against load.

The additional boiler plant which is required to operate the new units was supplied by Babcock and Wilcox, Ltd., as main contractors, with certain sub-contractors for the accessories. It is housed in an extension of the original boiler-house, and comprises eight water-tube boilers with chain-grate stokers. Each boiler has a grate area of 44·2 square feet, a

heating surface of 1827 square feet, and a superheater surface of 284 square feet. For driving the stokers there are (*a*) a steam engine and (*b*) an electric motor. Whichever form of drive is, at any given time, the more economical, will be used. The question will be decided by the temperature in the feed-water tank. If that be low, then the steam engine will be used, and its exhaust used to raise the temperature of the feed water on its way to the economiser. Working in connection with these boilers there are two sets of Green's economisers, with by-pass flues, each having 192 tubes and a heating surface of 1920 square feet. There are draught gauges over each boiler to indicate the pressures over the furnaces, in the downtake and in the main flues. There are also thermometers for indicating the temperature of the steam as it enters the main steam range from the mixing valve, for the purpose of regulating the superheat.

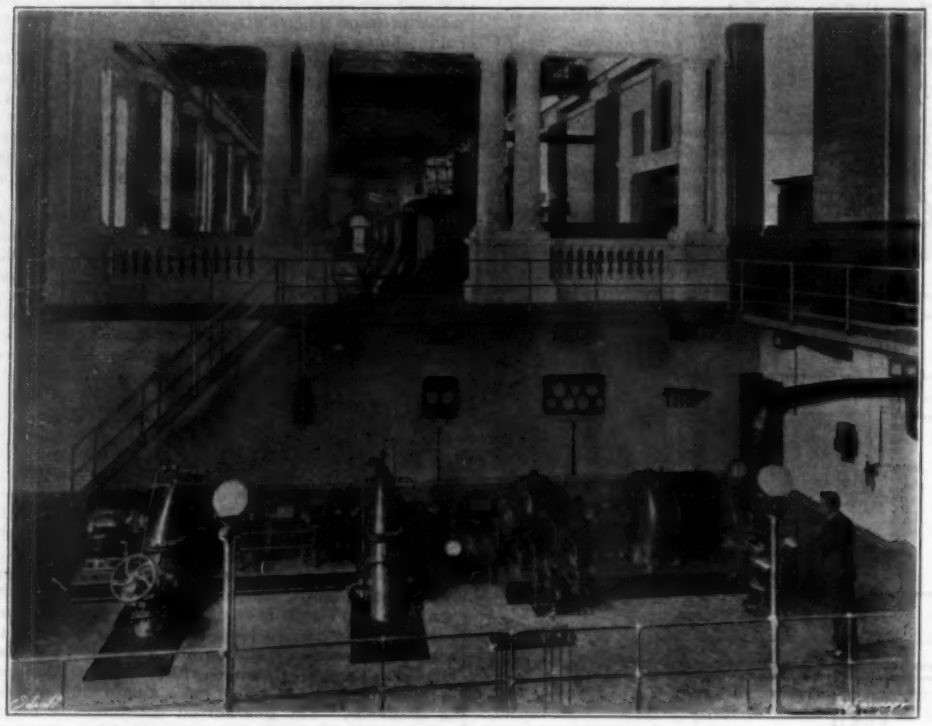


FIG. 21—HIGH-SPEED CENTRIFUGAL DUPLEX TURBINE PUMP

The steam range is provided with isolating and junction valves to each boiler, and is also well supplied with trapped drains and separators, and the whole system is lagged with magnesia and planished steel, so that it has a very finished appearance. The air pump discharge from the main engine is passed through an ash filter on its way to the feed tank, which is in the boiler-house. The feed water is passed either through a Lea recorder tank or direct to the feed pumps, which, it will be remembered, are worked from the main engine, or, alternatively, to the steam auxiliary feed pumps in the boiler-house, when they are at work. From the feed pumps the water either passes through two feed heaters or is by-passed direct to the economisers or the boilers. The first of the two heaters receives the exhaust from the stoker engine and the two auxiliary feed pumps in the boiler-house, when they are at work, while the second heater receives the jacket steam from the reciprocating unit before it passes to the feed tank. There is an auxiliary steam main from the stoker engine and auxiliary feed pumps, and it is connected to the original steam main. All the oily steam drains are, as explained above, discharged into grease traps and passed to filters.

The pumping station, as originally built, received its coal supply from barges in the river by means of an electrically driven aerial ropeway. As the extension is in a direct straight line with the original building, the existing arrangements had only to be extended. The coal is delivered from the buckets of the conveyor into overhead bunkers and thence descends to the feed shoots of the stokers, being weighed in Denison automatic weighers on its way. In like manner it was only necessary to extend the ash subway in the basement, and to move the position of the lift by means of which the ashes and clinker are raised to the ground level to be carted away or otherwise dealt with. It was not necessary to build another chimney, the original chimney having been made of sufficiently large internal dimensions to take in the gases discharged from the additional boilers.

The extension building which has been erected to house the machinery described in the foregoing has been made to harmonise well with the original building—of which it now forms an integral part—though since it has had to be made higher on account of the height of the reciprocating pumping unit, the architecture of the two halves of the building is not, in all points, the same. The general effect, however, is excellent, and the enlarged building is certainly a very handsome structure. In the interior, the system of decoration of the older portion, consisting of a pleasing blending of cream-glazed bricks and green glazed tiles, has been accurately copied in the extension. We may add that the contractors for the superstructure of the extension were Grace and Marsh, Ltd., of Croydon, and for the basement, &c., Messrs. Purnell and Clifford, of Slough.

It may be of interest to give some of the contract prices for the work. They are as follows :—

	£
The primary filter-house, secondary filters, sedimentation tanks, covered suction tank, chlorinating houses and other indicental works	116,115
The pumping plant and auxiliaries	66,950
The complete boiler-house plant	22,082
Superstructure of the engine-house	34,366
Works in the basement	23,656

In conclusion, we may repeat that the whole of the work, which throughout is of really first-class character and well up to the high standard which the Water Board has laid down for itself, has been carried out to the designs and specifications of Mr. Henry E. Stilgoe, M. Inst. C.E., the Board's Chief Engineer, to whom we desire to express our indebtedness for the facilities which he afforded us for visiting the station and for obtaining information regarding it, as well as for the drawings and photographs from which our illustrations have been prepared. We would also like to tender our thanks to the several members of his staff with whom we had the pleasure of coming into contact, for the help they have given to us in the preparation of our articles.

FIG. 22—VIEW ALONG BOILER-HOUSE

British Association.

NO. II.*

SECTION G.

ELECTRICITY SUPPLY.

BEFORE the Engineering Section of the Association on August 6th a broad review and some subsidiary aspects of the electricity supply problem formed the chief items in the agenda.

Sir John Snell devoted his presidential address to an attempt to estimate the probable increase in the demand for electric current, and the measures which are being adopted to meet that demand. He pointed out that the growth of the industry had been very rapid, and that within a period of thirty-seven years there had been expended by authorised undertakers in Great Britain—excluding railways and private plants—no less than £200,000,000. He traced the course of the struggle between the advocates of direct and alternating current, the formation of numerous small-scale undertakings, the evolution of methods of distribution from the simple two-wire system, and praised the pioneer work of Dr. Ferranti, who was the first to advocate generation on a large scale and transmission by high pressure over an extensive area of supply. The revolutionary discovery of the practical application of multiphase currents and the introduction of the steam turbine were also referred to.

To-day, Sir John continued, the position was that output was increasing very rapidly, and that current was being generated at diminishing cost. With the reforms now suggested, by the adoption of one standard frequency, and by a reduction in the number of supply pressures, a tremendous increase in demand was in sight. At the present time, the amount of electricity generated in Great Britain, omitting privately owned generating stations, amounted to about 7000 million units annually, of which 5069 millions were sold by authorised undertakers, the balance being required for railway and tramway traction purposes. In recent Government publications it had been estimated that the output in Great Britain within the next fifteen years might reach a total of 21,000 million units, or an even higher figure, if electricity systems fulfilled the requirements of a more extensive railway electrification.

It was necessary to visualise the possible development in order to plan the engineering system and methods of distribution, while paying due regard to the more immediate needs. Taking all factors into consideration and assuming the population at the end of the next twenty-five years would have grown to 50 millions, and that the methods and extent of distribution had advanced and developed and that a sensible reduction could be effected in the cost of appliances resulting from scientific and commercial improvement and greatly increased scale of manufacture, the total output for domestic requirements, including residential premises, shops, offices and public places, might be estimated at not less than 20,000 million units, with a maximum load of 8 million kilowatts. With regard to the industrial demand, it could be fairly assumed that if the majority of our industrial works—omitting certain classes which required steam for particular processes—derived their supply from public systems of supply, and if an increasing use of power per employee could also be assumed, a future output for industrial power of not less than 20,000 million units, with a maximum load of 9,200,000 kilowatts was in prospect. The railway demand should also increase to a considerable extent. The present output for railway traction was about 700 million units a year; but it should develop to about 7000 million units. That gave a total demand for domestic, industrial and railway use of 47,000 million units, representing a maximum demand of 19,200,000 kilowatts. It had to be borne in mind that the average yearly load factor, or units sold by undertakings, in Great Britain was to-day under 25 per cent. The sources of power available in this country were mainly coal and coke, but there were also inland and tidal water power to a small extent, and some sources of waste heat. It was certain, however, that the bulk of this future electrical output must be produced in fuel-fired stations. The inland water supplies were probably at least 400,000 kilowatts, continuous rating, and tidal power could be estimated at worth about 1000 millions a year, but the balance would be supplied from fuel stations.

The task which lay before the electrical engineer was two-fold: to obtain a reduction in the consumption of coal per unit generated and a reduction in the capital expenditure. Many refinements could be employed which might economise coal, but at the expense of an undue capital expenditure. Broadly speaking, the employment of bigger stations and an increase in the size of plant employed reduced the capital employed per kilowatt of plant installed. Interconnection of stations further reduced the percentage of reserve plant, and thus reduced the capital employed per kilowatt of plant demanded. The development and steady improvement of the steam-using plant at the generating station was proceeding satisfactorily, and we were certainly within sight of a heat consumption not exceeding 12,000

* No. I. appeared August 6th.

B.Th.U. per kilowatt-hour generated at base load stations. Where a group of stations was interconnected, the peak load stations with annual load factors of only about 20 per cent., would, *cæteris paribus*, require a fuel consumption of about 20,000 B.Th.U. per kilowatt-hour generated. Although the annual load factor was low, the programme for running the plant could be so arranged that the plant load factor was high. There was a probability that fewer refinements would be commercially justified in peak load stations, and, in the estimates made, the heat consumption at such stations was advisedly taken at 22,000 B.Th.U. per unit generated. The average B.Th.U. per unit sent out or available for transmission would thus be 16,500 at a station load factor of 35 per cent., and representing a thermal efficiency all round of 20·6 per cent., which would be a notable advance on the last recorded figure of 12·45 per cent. for the whole country.

There was also the steam-raising plant to be considered. With the coming of the larger turbine, a demand had arisen for large boiler units and higher evaporative capacities. Boilers having an evaporative capacity of 300,000 lb. per hour were already in commission, and higher pressures were being employed. Consideration was being given to the more extended use of pulverised fuel. What was being done raised the possibility of commercially utilising the waste from coal mines, which would appear to bring within the ambit of possibility a combination of some form of low-temperature carbonisation of the fuel so as to enable some of the valuable by-products to be recovered, coupled with the production of a soft coke which could be applied in a pulverised form to the boilers for steam-raising purposes. Suggestions had been made that gas and electricity undertakings should be combined for the purpose of conserving fuel, but although a large number of local authorities owned both gas and electricity undertakings, there was no instance of a complete amalgamation having been effected. It was for the gas industry to show whether it could supply heat to future large power stations in the large volumes necessary in modern practice, at rates which would be no greater than the equivalent cost of raw coal and in forms which would be as efficient in application to boilers of large evaporative capacity. If it could do so, then assuredly electricity undertakings should, in the national interest, give the fullest consideration to such a proposal. Whatever the future might bring forth, it was certain that developments were taking place which would bring about a substantial reduction in the cost of generating electricity and effect a more scientific utilisation of natural fuel resources. Any system which could recover the greatest amount of the stored energy available in coal should be fully explored, and it was the large power station of 200,000 kilowatts and upwards that would appear to offer a means of investigating the value of new fuel processes on a practical scale.

There was very little doubt that within a few years electricity would be generated at modern power stations, even with direct firing, at a figure of 0·3d. or less per unit. Current would be transmitted at high pressures for such purposes as railway traction, and large blocks of industrial power would be supplied in bulk to local undertakers, who, in turn, would retail it to their consumers. That involved the construction of high-tension transmission lines or cables and the provision of transformers and switchgear. Broadly speaking, transmission costs would add 10 per cent. to the cost of the units sent out from the power stations, assuming a reasonable average load factor. It should be possible therefore to transmit energy in quantity and transform it locally to the required service pressure at a cost of 0·33d. or less per unit sent out when applied at an average load factor of, say, 33 per cent. That cost of bulk supplies was equivalent to about 0·4d. per unit transmitted and delivered by means of high-tension mains, and transformed locally to the requisite pressure.

The highest working pressure on three-core cables so far applied in practice had been 66,000 volts between phases or 37,500 volts per phase to earth. The construction of three-core cables for large power transmission, *i.e.*, with conductors of 0·25 square inch, for example, offered great difficulties of both an electrical and mechanical nature. Moreover, the short lengths in which such heavy cables could only be constructed entailed the use of numerous joint boxes. It would seem that future practice in cable transmission at the higher pressures must tend towards the adoption of single-core cables which could be manufactured in greater lengths and with greater facilities in the factory. Single-core cables were now being constructed with a pressure of 132,000 volts between phases or 76,000 volts to earth, and cable manufacturers were confident that such cables could be applied with safety.

It was the cost of local distribution which caused a considerable addition to be made to the cost of generation and transmission, and in which economies must also be made possible in future extensions. As the published official statistics showed, the present average capital expended on distribution systems in Great Britain was £21 per 1000 units sold, including the cost of sub-stations. It was not unreasonable to assume that future capital investment in distribution would not exceed £11 or £12 per 1000 units sold, since the bulk of future distribution would be by means of alternating current and the simpler static transformer sub-stations.

Assuming that the average price of coal—of 10,500 B.Th.U. value—delivered to the generating stations throughout the country was 20s. per ton, it was safe to say that the average price at which electricity should be available within a few years should be under $^9/_{16}$th of a penny per unit.

Sir Oliver Lodge, in moving a vote of thanks to the President of the Section for his address, said that the most remarkable fact in connection with the business of electric supply was the short space of time in which it had been developed to its present magnitude. It was now recognised that the electrical method was the most economical form of power distribution, and the time was not far distant when all requirements in the fields of industry and railway operation and lighting, heating and cooking for domestic and other requirements would be carried out by electricity. An old test of civilisation was the quantity of soap used; the new test would be the quantity of electricity demanded.

Economics of Electrical Distribution.

Mr. J. N. Kennedy in a paper then dealt with some features of the economics of power distribution. He said that some 90 per cent. of the electricity generated in Great Britain was in the form of alternating current three-phase at about 6000 or 11,000 volts, and such supplies were in a great measure converted into direct current and sold as such. For any new distributing system starting at the present time, it was much more economical to distribute low-tension alternating current rather than direct current, owing to the smaller capital outlay and smaller losses in converting plant. If the proposals now before Parliament for the co-ordination of generation throughout the country materialised, the majority of the existing undertakings would be able to purchase electricity in bulk at considerably lower prices than those at which they could at present generate in their own stations, and they would thus become distributing authorities only.

His object was to consider some of the problems which arose for solution under this new set of conditions. The relative importance of the generating and distribution side of the electric supply business at the present time should be considered in this connection. The total amount invested on electric supply undertakings in Great Britain at the end of 1924–25 was £194,000,000, of which 54·6 per cent., or £106,000,000, had been invested in the distribution side of the system. From the capital point of view, therefore, the distribution side was more important than the generating side. With co-ordinated generation in the future it seemed probable that the capital spent on distribution would amount to a still greater percentage of the whole than at the present time. Summarising the position as revealed in published statistics, the distribution side of the electrical business in Great Britain could be regarded as an undertaking having in the year 1925 a capital invested of £106,000,000, with a total revenue of approximately £42,000,000. To earn that revenue the distribution undertaking had to pay for its raw material—*i.e.*, electricity in bulk—an amount of £26,000,000 to the generating authority. The fixed charges in connection with any generating undertaking divided by the number of kilowatts of maximum demand supplied gave the "fixed charge per kilowatt of maximum demand." Similarly, the running charges of any generating station divided by the total number of units sold represented the "running charge per unit." This method of charging was adopted almost universally in connection with bulk supplies from one undertaking to another. The work done on the "raw material" before it reached consumers' premises involved the distributing authority in the expenditure of considerable sums of money on distribution mains and plant. The undertaker who supplied low-tension alternating current had to invest in transforming plant only £4 per kilowatt of maximum demand—for an average-sized sub-station—as compared with £10 per kilowatt for converting plant in the case of an undertaker supplying direct current. The cost of the low-tension mains and services themselves was the same for either alternating or direct-current distribution at the same voltage and amounted to an average of £20 per kilowatt of maximum demand. The amount of money spent both on capital and revenue accounts was principally dependent on the maximum demand which the distribution system had to deal with, and all outgoings of that character therefore were fixed irrespective of the number of units sold. On the other hand, the losses of units in the transmission and conversion system were almost entirely dependent on the number of units sold, and the cost of the lost units had therefore to be added to the unit charge of the bulk supply.

Considering the net amount which the distributing undertaker had to charge to each of his consumers, it must be borne in mind that among a large number of consumers there was a considerable diversity factor on maximum load, and it was necessary for the distributor to lay out his system to cater for the arithmetical sum of all the consumers' maximum loads. It was a fair assumption for an average case to allow a diversity factor of 1·33 on the kilowatt charge. Assuming that a bulk supply was available at the price of £4 per kilowatt, the tariff for a low-tension alternating current supply delivered to consumers' premises would be $\frac{£4 + £3 \cdot 9}{1 \cdot 33}$ = approximately £6 per kilowatt of consumer's maximum demand. If the bulk supply unit charge was 0·2d., that figure would be subjected, in the case of a low-tension alternating-current supply, to an increase of 20 per cent., making the retail price, say, 0·24d. per unit sold to the consumer. The lower the unit charge in the bulk supply tariff, the more possible would it be for the distributing undertaker to make his tariff attractive for consumers requiring a large number of units at a very cheap rate. Similarly, for a low-tension direct-current supply the tariff would work out at £6 12s. per kilowatt of maximum demand, and 0·254d. per unit sold. While it is not necessarily possible or expedient to charge all consumers on a two-part tariff, it was necessary for the distribution authority in framing tariffs to divide up costs in that manner, so that in formulating rates for off-peak supplies, the running charges in connection with his supply were amply covered. Any authority framing attractive tariffs to sell electricity within the above price limits was sure of a large business.

The question was how existing undertakings which were only selling on the average 47 units per £1 of capital invested could improve their position. The statistics showed that over 44 per cent. of the total revenue was received from domestic consumers. That represented rather less than 18 per cent. of the total units sold in 1922–23, the average revenue from those consumers being 5·3d. per unit. The scope for extension was indicated by the fact that sales of units to domestic consumers amounted to less than 20 units per head of population served for domestic supplies. It had only recently been recognised that the domestic consumer really offered one of the widest fields for the development of electricity supply that existed in Great Britain to-day. Many undertakings, especially the large municipalities, recognising the field open, were now offering supplies to "all-electric" houses at most favourable terms. If electricity was taken for lighting, heating and cooking, the average price per unit worked out at well under 1d. per unit.

The distribution of electricity did not, as many imagined, entail any very serious losses. Taking as an example a generating efficiency of 21 per cent. and 15 per cent. losses in the distribution system, the consumer obtained 18 per cent. of the heat value in the coal. He had the further advantage in using electricity that for every purpose it could be used at very high efficiency. For lighting or heating the efficiency came out at a very high figure. For power purposes, the efficiency was also high but depended on the size of motor used.

We were on the eve of very great electrical developments, and in order that those developments should proceed on the right lines, the distribution side of the business required the most careful and capable guidance. More capital would be spent in distribution than on generation, and if the engineering talent, which had hitherto been fettered by questions of generating costs and policy, was set free to devote itself wholeheartedly to the question of selling energy, the only limit to the growth of sales would be the amount of capital available.

Professor E. W. Marchant, in the discussion which followed this paper, referred to his own experience in Liverpool in support of the contention that a reduction in the tariff stimulated demand to a remarkable extent. He could confirm the statement in the paper regarding the great importance of the domestic load, which was not always recognised.

Professor William Cramp criticised public authorities concerned with electric supply for their unenterprising policy. A majority of these bodies preferred to defer making any forward step until they saw an actual profit on a new tariff. They overlooked the fact that a business undertaking making expansions, must be prepared for initial losses. Professor Kennedy had done useful service in directing attention to the costs of distribution under the new scheme of electricity supply, and it remained to be seen whether the large outlay involved would be justified. Referring to the tariff question, the tendency in framing scales was to encourage owners of works with large load factors to take current from public sources of supply, but to disregard the requirements of small works with low load factors. The disparity in tariffs for large and small consumers was, in his opinion, a mistake, and had a great bearing on the chances of success of the new scheme of supply. Steps must be taken to attract all classes of consumers by skilfully planned tariffs.

Mr. Kennedy, in reply to the discussion, admitted the tendency of many supply authorities to lag behind demand instead of taking steps to stimulate the wider use of electricity. With regard to distribution costs, there would not be an actual increase in amount under the new Bill, but owing to the reduction in the cost of generating current, the percentage of total costs absorbed by the transmission system would be greater. Proof of the manner in which the electric supply industry had developed within a comparatively short period, as pointed out by Sir Oliver Lodge, was given by the fact that in the presidential address to Section G of the British Association given by his (Mr. Kennedy's) father thirty-two years ago, the only

reference to electricity was a brief mention of the lighting of towns.

Electric Ploughing.

Mr. R. Borlase Matthews then gave an account of recent advances in the application of electrical methods to ploughing. It was not, he said, universally recognised that agriculture required more power than all other industries combined. Of that power, by far the greater part was required for cultivating the soil. Not only was ploughing one of the most important and heaviest of farm tasks, but it was also the most expensive item in the arable farmer's bill. The economics of the question had arrived at the stage at which it was necessary for the engineer to step in. The question of increasing the rate at which the work was carried out seemed to offer the greatest benefit. Results had shown that the cost of the extra power required to perform any cultivation at a higher rate than was usually done to-day was much less than the amount saved in labour and other costs. It was therefore important to examine what contribution electricity could make towards solving the problem. Continental engineers had given a great deal of attention to the matter, with the result that there were over 200 electric ploughs in use on the Continent to-day. There was still, however, a great deal of research and experimental work to be done, not only in the method of using the electric power, but also in the re-design of the actual implements.

Many scientists doubted whether the operation of ploughing as at present practised was really an essential part of tillage. The efficiency of the plough now used was very low, and its design was based on rule-of-thumb methods. There were numbers of different systems of electric ploughing in operation to-day, though they practically all fell into one of two classes, viz., tractors or rope haulages. A machine representing a considerable improvement in electric plough design had been designed by N. Forssblad, of Sweden. A tractor of this type, with three shares, would plough, on an average, 6 acres per day to a depth of 8in. The current consumption was, said Mr. Matthews, about 28 units (kilowatt-hours) per acre. Major A. McDowall had, he continued, recently developed an original form of creeper tractor, which fell within the group of automatic cable winders. It had the great advantage of minimum wear on the cable, as it was provided with an automatically movable self-winding supply point. The tractor also incorporated a novel method of side stepping the whole machine, ready for the next furrow. The steel wire rope electric haulage systems had a number of advantages over all others when employed in large and powerful units. A double haulage system with two single-drum winders, one progressing up each side of the field, was perhaps the most popular type of equipment for farmers. Its capacity for work was enormous. It would plough up to 30 acres in one day, as compared with a bare acre for a team of horses. One of the best examples of this type of equipment was supplied by the Société Générale Agricole, of Paris, and had been in use in France for a number of years. Each set was fitted with either an 80, 100, 125 or 150 horse-power, 5000-volt, three-phase, slip-ring, induction motor, which was protected against rain and was capable of a momentary overload of 60 per cent. The makers supplied the whole of the necessary equipment, including haulages, plough, transformer wagons, flexible cable and hooks for tapping the high-tension line. An auxiliary petrol engine of 50 horse-power was fitted to each set for moving it from place to place. Another double-haulage equipment in France was that designed by Estrade. Each set was equipped with a 35 horse-power, three-phase, squirrel-cage type motor, which could be coupled to the wheels so as to move the haulage. It was designed for two speeds of 1·83 or 2·75 miles per hour, and was much lighter and less expensive than the previous set. It was capable of ploughing 6 acres in an eight-hour day. A special feature of this equipment was a very ingenious anchoring device, which permitted of comparatively light weight haulages.

A two-motor equipment, which was supplied by Siemens-Schuckert, consisted of two winding trucks. The drum for the steel cable was mounted on the winding truck and was equipped with a powerful automatic brake for paying out the cable. There was also an auxiliary brake for the operator's use, which could be released instantly. An 80 horse-power, 750-volt, three-phase motor was used for driving the gearing of the cable drum. The main driving motor of the tractor was 30 horse-power, three-phase, with controller, and oil switch with overload device. The cable drive was operated by an additional small motor through a friction drive, the motor being provided with a special hysteresis control rheostat. Owing to the hysteresis control, the operation of the motor was automatic, and the machine did not tend to burn out when it was at rest. It was claimed that with these sets the current consumption for depths not exceeding 7in. was as low as 15 kilowatt-hours per acre. As a result of tests carried out on his 600-acre farm at Greater Felcourt, East Grinstead, and his investigations in all continental countries where electrical ploughs were in use, he had concluded that the most suitable equipment for the individual farmer with 150 acres and upwards would be an electric tractor with a half-creeper track, a storage battery, a trailing cable, an automatic reel on the tractor, and an automatic and movable supply point at the centre of the furrow supplied from the side of the field. A tractor of that type could also carry out such work as cultivating, harrowing, rolling, seed drilling, harvesting, &c., and could also be used for road transport.

The advantages of electric ploughing might be summed up as follows:—(1) Practically unlimited power was available behind the plough, thus any obstruction within the power of the plough could be overcome; (2) deep ploughing was possible, an important factor in the growth of sugar beet, sugar cane, &c.; (3) the cost per acre for electric power was considerably lower than for the fuel in non-electric types of plough; (4) low labour costs, as compared with other forms of fuel, *e.g.*, the work of carrying fuel and water was entirely eliminated, and (5) an increase of marketable produce.

Professor E. W. Marchant, in the discussion which followed, said that he regarded the subject raised as of great importance. The difficulty in the application of electricity to farming operations appeared to be the bad load factor, while the capital outlay involved was rather large. The difficulty of high initial cost might perhaps be overcome by co-operation among local agricultural interests.

Mr. J. R. Bond, approaching the question from the point of view of the farmer, agreed as to the advantages of mechanical power, which would be available at the right time, and could perform necessary operations quickly. It was, however, important to exercise care in the choice of mechanical equipment, and he was bound to say that farmers had had rather costly experience with oil tractors. They wanted assurances regarding reliability and a cheaper type of machine before acquiring electrical plant. The question of weight was important, as sometimes equipment of the type described was too heavy for the land. Ease of transport from one point to another on the farm was a further consideration.

Mr. Borlase Matthews, in replying, emphasised the importance of electricity on the farm to the electrical industry as well as the farmer. The load factor on farms was, not as Professor Marchant seemed to imagine, low, but of a rather attractive character.

Electric Conduction.

Professor Wm. Cramp presented a paper in which he discussed some phenomena of electric conduction. He said that an electric current was generally assumed to be due to the relative motion of protons and electrons. Conditions were, however, different in metallic and electrolytic conduction, and the question arose whether the magnetic field produced by an electrolytic conductor was the same as that obtained when a metallic conductor of similar form carried the same current. He had compared the magnetic field produced by a tube of electrolyte carrying a given current with that produced by the same current when the tube was full of mercury. The electrolytes used were respectively silver nitrate and hydrochloric acid. Two methods of measurement were adopted for the magnetic field, viz., (1) the ballistic galvanometer method, and (2) the direct reading magnetometer. In all cases the magnetic field due to the silver nitrate was less than that due to the mercury, and that due to the hydrochloric acid was slightly less than that due to silver nitrate. Further, by both methods the percentage difference was very nearly the same, viz., just under 2 per cent. as between mercury and hydrochloric acid. He had reached the conclusion that the difference was due to the fact that in the metal, conduction brought about an electron drift of comparatively high velocity. To prove that, experiments were made upon metallic conductors in which there was a sudden change of section. By measurements taken on reversal of the current a limiting value of electron velocity in metals was obtained and shown to be far higher than that of the ions in a solution. That, in the author's opinion, introduced phenomena at the cathode which hitherto had been neglected, but which were plainly visible in the case of silver nitrate, and was sufficient to explain the observed differences between the magnetic fields due to metallic and electrolytic conduction. The conclusion was that the usual assumptions concerning the relationship between current and electron or proton movement were correct for metallic and for electrolytic conductors; but that where a circuit contained both, the new electrode phenomena must be taken into account.

SECTION F.

Economic Aspects of Labour.

In raising the question of effective collective bargaining as the basis of industrial stability, Sir Lynden Macassey made an opportune contribution to a subject which has become of increasing importance. Recent failures to achieve the desired conditions in this respect were to be attributed, he thought, to the absence of representative and responsible employers' federations and trade unions. Present-day requirements had, he insisted, altogether outstripped current legislative principles and conceptions, as they demanded from both employers' and workers' organisations a quickness of response which was beyond the power of their ponderous and slow-moving machinery. The kernel of the problem was reorganisation of employers' federations and trade unions on lines which would make them as competent and responsible parties to industrial agreements concluded by them as any other person not under legal disability in respect of a contract. That meant, in effect, providing for the validity and enforcement of collective agreements, which, in Great Britain, unlike most foreign countries, were not enforceable by law and were for that reason frequently disregarded. Cases of the kind were within recollection and had inflicted great losses on industry as well as striking a blow at the principle of collective bargaining, the retention and proper application of which was essential to obtain stable conditions in industry.

Sir Lynden Macassey went on to say that, having regard to the tendency to disregard agreements, the only method which seemed likely to effect the desired object was to make the contracting parties subject to the obligations and the rights of ordinary contracting parties. That would involve the disappearance of the sympathetic strike and lockout, as both would constitute breaches of the agreement and of the law. The substitution of force in the forms of sympathetic strikes and lockouts in place of seeking legal remedies must be prevented. The difficulties of the task were admitted. It involved reconstitution of the big employers' federations and trade unions, which was in itself a great undertaking. The end at which to aim was to put those bodies in a position of being able, not only to ascertain, but to reflect the views of a majority of their members. That was certainly not always the case at the present time, and it was that fact which served to explain why industrial agreements were disregarded.

SECTION J.

Accidents in Industry.

Mr. A. Stephenson gave a brief account of recent investigations into the incidence of accidents in industry. He said that a report made in June last, giving the results of an investigation by Mr. James W. Davis, Secretary of Labour in the United States, showed that the fatal industrial accidents in the United States probably exceeded 23,000 a year and non-fatal accidents 2½ millions a year. The wage loss was over a thousand million dollars annually and the working days lost was estimated at 227,169,000. It was stated that 85 per cent. of the accidents were preventable. In Great Britain there were about 1200 fatal accidents per annum in factories and workshops and another 1200 in coal mines and quarries. Non-fatal accidents of sufficient severity to cause disablement for a week or more numbered 120,000 a year in factories and 200,000 a year in coal mines. It was estimated that about one-third of industrial accidents were attributable to machinery, and not more than one-third of those machinery accidents were due to the absence of guards. That left 90 per cent of present-day accidents to be accounted for as failures on the part of the human subject. The capacity of the worker to protect himself had been overrated. Investigations had been made into the relation of accident frequency to speed of production, fatigue, illumination, methods of work, experience, age, hour of day, labour turnover, &c. It had been shown by statistical methods that the average number of accidents was much influenced by a comparatively small number of workers. The bearing of that on mass production work was important. The assumption that it was only necessary to arouse the workers' sense of responsibility was not always justified. The influence of experience on tendency to accident was a moot point. It seemed reasonable at first sight to assume that the inexperienced worker would be more liable to sustain accidents. As the result of an investigation conducted by the National Institute of Industrial Psychology, it appeared to be demonstrated that susceptibility to accident could be detected and that ability to acquire the neuro-muscular co-ordination required by the particular process and to attain the necessary degree of manual skill and dexterity was at least as important a factor as age or experience. Workers' organisations might with advantage sponsor the investigation of individual proneness to accident, particularly in the mining industry, with the object of preventing the entrance of youths into trades in which they would be a menace to themselves and their co-workers. In highly organised plants, in which the rate of one productive operation was dependent on the rate of the previous operation, it was evident that effects of impaired efficiency, due to a relatively slight accident to one worker, might become cumulative, and affect the rate of the squad, and so of every subsequent process. If the necessary technique for minimising accident risks could be perfected and the application of tests made universal, very far-reaching effects could be anticipated.

Restriction of Output.

Mr. A. Angles said that it was not unusual to blame the trade unions for restriction of output, but no case supporting that contention had come under his notice. There was, however, no doubt that restriction was practised. In general it was an action by a group of workers against conditions which they believed to be unfair. It was usually brought about by a strong feeling of class loyalty which in some cases overcame self-interest. Where restrictions were being practised it was usually revealed by a remarkable uniformity of output. Workers advanced many reasons in defence

of their action, but two were sufficiently frequent to command attention. They were the familiar fear of rate cutting and the fear of unemployment. Other reasons were fear of discharge of incompetent workers, influence of the foreman, general dissatisfaction with working conditions or satisfaction with existing earnings and consequent lack of incentive. These general conditions varied enormously according to the efficiency of the management, but it was a general rule that where the mental atmosphere was good restriction of output was a very rare occurrence.

Models and Analogies for Demonstrating Electrical Principles.

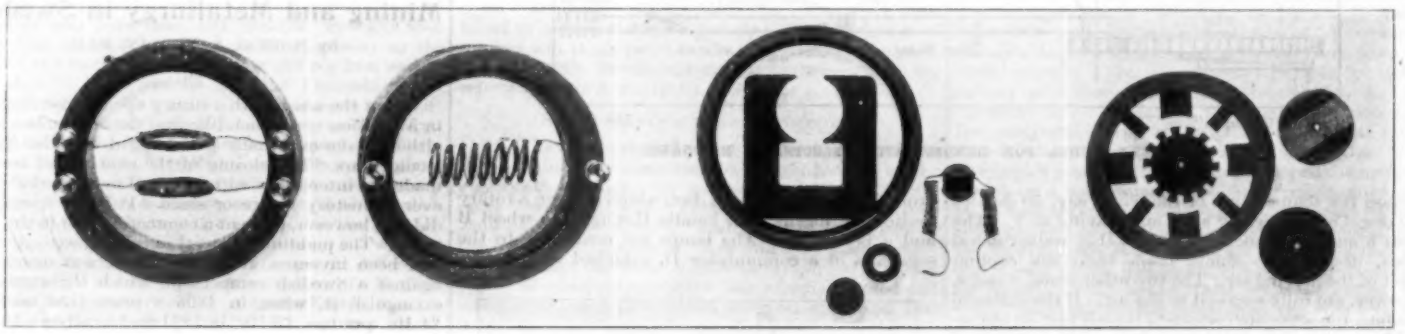
No. I.

To teachers of electrical engineering mechanical models and analogies are often a considerable help, for they enable students to grasp theories and ideas which present difficulties to the non-mathematical mind. While few would assert that mathematical treatment should give place entirely to mechanical demonstrations, a physical conception of processes and results is frequently required. Students to whom a mathematical demonstration does not convey a proper explanation, invariably endeavour to form a mental picture of what is going on, and analogies are then of very great assistance, provided they are not overstrained. When, for instance, a mechanical mass is substituted for inductance, and a spring for capacity, as in Mr. Clinker's oscillating valve model, and in various other models, the analogy is so close as to make it seem that the same two fundamentals are being dealt with in the mechanical and electrical cases. There is another class of model which is designed merely to show the parts of electrical machines and apparatus to a large class of students, and in which no analogy is involved.

FIG. 5—LANTERN MODEL OF A.C. MOTOR

In this and subsequent articles it is proposed to describe certain models and analogies used in teaching electrical engineering in various technical schools and colleges. Our appeal to professors and others to supply information for these articles has revealed the fact that whilst some are keen on the use of models and analogies, others do not employ them at all. On the whole, the response to our request for information has not met expectations, but it is hoped that our store of material will be augmented as the articles appear.

Perhaps no one has done more to encourage the use of models for explaining electrical theories and principles than Dr. Drysdale, who, we are glad to say, has responded to our appeal for assistance. His book on the "Foundations of Alternating-current Theory," published by Edward Arnold, has undoubtedly proved a great boon to many students, who are unable to master alternating-current principles with the aid of mathematics alone. With the help of models and analogies, Dr. Drysdale has succeeded, in this well-known work, in dealing with many branches of alternating-current theory in a relatively simple manner, and it is with great satisfaction that we are able to announce that he has consented to provide material on this occasion. In the first place, however, we shall consider a few models of a very simple kind, designed by Mr. Paley Yorke, of the School of Engineering and Navigation, Poplar, for lantern demonstration and suitable for use in any ordinary lantern having a 4¼in. or larger condenser. With the aid of these models, experiments and different kinds of electrical apparatus can be shown to a large class of students. Two of them are illustrated in Figs. 1 and 2, the former having been designed to show by means of iron filings the lines of force in the neighbourhood of a single or two parallel coils wound through holes in glass and carrying current; whilst the model illustrated in Fig. 2 shows the lines of force in the neighbourhood of a single solenoid, as revealed by iron filings sprinkled on the glass, as in the case of the model shown in Fig. 1.



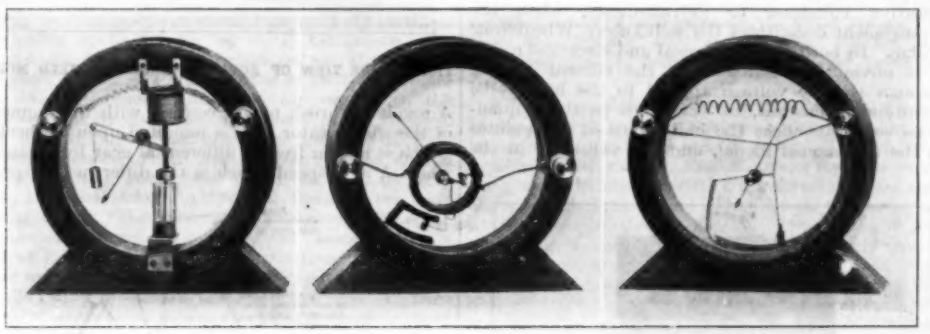
FIGS. 1 TO 4—LANTERN MODELS FOR SHOWING MAGNETIC FIELDS BY MEANS OF IRON FILINGS

By means of iron filings it is possible with the model illustrated in Fig. 3 to show the lines of force in an interpolar field between the curved pole pieces of a two-pole magnet. A piece of soft iron, an iron ring and a wound "H" armature are provided, and when placed between the pole pieces of the magnet, the iron filings readily show the effect upon the magnetic field. The distribution of the field, due to magnetisation of the "H" armature by passing a small current through the winding can readily be demonstrated. The apparatus consists of a glass base in a polished teak frame, similar to that of the other models, with a cover on which to sprinkle the filings, and the armature and solid disc and ring, as shown.

Another interesting model designed by Mr. Paley Yorke is that of a four-pole dynamo field magnet of the enclosed type for demonstrating the nature of the inter-pole field under different conditions. As in the case of the model shown in Fig. 3, the poles are permanently magnetised. A set of three armature cores, to be seen in Fig. 4, is provided—a plain, a slotted core, and a permanently magnetised core, which is used to represent the magnetic state of the armature, when dealing with a load. The interpolar field, in each of these cases, can be shown by means of iron filings sprinkled on a glass plate placed over the model, and the armature distortion produced by the loaded armature is specially well demonstrated. The four permanently magnetised interpoles can readily be put into position, when the effect upon field distortion and leakage is at once made apparent.

In Fig. 5 is shown a working model for demonstrating the action of a single or two-phase alternating-current motor, and for use in the lantern. The stator is built up of iron stampings, and is provided with two sets of windings to give consequent poles, whilst the rotor consists of a circular copper band mounted so that it is capable of rotating about a central pivot. The motor will operate with a current of about 1 ampère in its windings. When it is desired to make it run as a single-phase machine, a non-inductive resistance is connected in series with one set of windings, and an inductive resistance in series with the other, so as to produce the requisite phase displacement. When, on the other hand, it is required to make the machine work as a two-phase motor, the windings are, of course, connected to the respective phases of the supply.

Mr. Yorke has designed a number of other models for use in the lantern, but it will suffice to refer to the three illustrated in Figs. 6–8, which are models of electrical instruments. The model illustrated in Fig. 6 shows the principle of a Kelvin ampère gauge, with a dashpot, for making the movement dead beat; whilst the model, Fig. 7, gives a good idea of the principle of an electro-magnetic ammeter or voltmeter of the repulsion type, with the air-damping chamber shown in section. The other model, Fig. 8, shows clearly the working of a hot-wire ammeter. The main part of the current passes through the low-resistance spiral, whilst a small fraction of it is shunted through the fine wire stretched across the case, the arrangement for taking up the sag and for moving the pointer when the wire becomes heated being clearly indicated. In order to make the model as simple as possible, no damping device is shown.



FIGS. 6 TO 8—LANTERN MODELS OF ELECTRICAL INSTRUMENTS

We are indebted to Professor MacGregor-Morris, of the East London College, for particulars of a model, constructed in the form of a lantern slide, for demonstrating the principle of electrical resonance, which is particularly useful for showing how wireless circuits, having different values of inductance and capacity, are tuned at definite frequencies, it being a model in which mass represents inductance and springs capacity. As shown in Fig. 9, the model consists of a toothed wheel and fly-wheel, turned by means of a handle. The toothed wheel meshes with a pinion on the spindle, on which there are two excentrics, which, by means of two flexible bands, give a reciprocating motion to two horizontal steel wires, attached to spiral springs, as shown. These wires pass through holes in two vertical flat springs provided with weights W_1 and W_2 at different points, so that the flat springs have different natural periods of vibration. On each of the horizontal steel wires there is a small lump of solder which hits the vertical flat springs as the horizontal steel wires move to the left, with the result that, when the blows are administered at the correct intervals, one or the other of the vertical springs is set into extensive vibration. As these weighted springs have different natural periods of vibration, they never vibrate together, the particular spring that is set in motion depending, of course, upon the speed at which the hand wheel is turned. Damping is provided by means of camel's hair brushes attached to the upper ends of the flat springs, which brushes rub on the inner side of the metal case in which the mechanism is placed. The model is very effective, and as it is constructed in the form of a lantern slide, is useful for explaining the principle of tuning to a class of students.

Professor MacGregor-Morris also described in a paper read before the British Association in 1920 a mechanical model of a Wheatstone bridge. The paper dealt with a portable direct reading anemometer for the measurement of ventilation in coal mines, but it will readily be seen from the diagram,

Fig. 10, illustrating the mechanical model of the apparatus, that the arrangement really constitutes the well-known Wheatstone bridge. Four thin wires *a*, *b*, *c* and *d*, each of the same length, are arranged as shown, and a sufficiently strong constant current flows through the two paths in parallel, *a b* and *c d*,

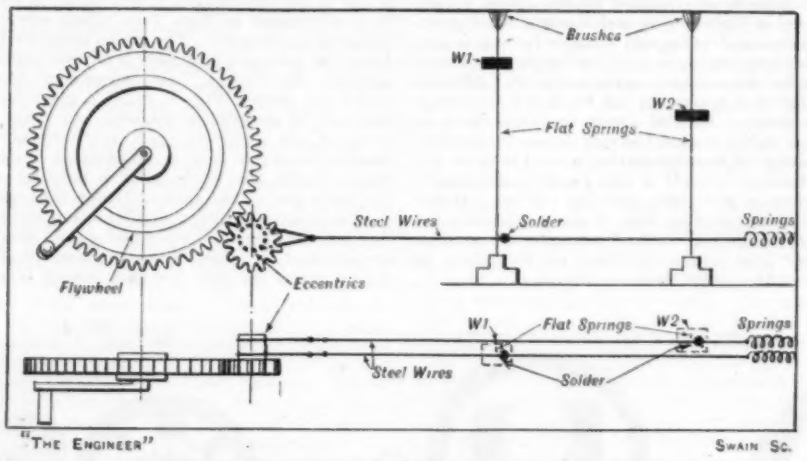


FIG. 9—LANTERN MODEL FOR DEMONSTRATING ELECTRICAL RESONANCE

to raise the temperature of the wires, say, 50 deg. to 100 deg. Cent., entering at X and leaving at Y. The wires *b* and *c* are enclosed in two thin walled metal tubes, designed to shield them from the cooling effect of the moving air. The two other wires, *a* and *d*, however, are fully exposed to the air. If the material of which the wires are composed is such that an appreciable change of length takes place with a change of temperature, then the greater the velocity of the wind blowing upon the apparatus the shorter will the wires *a* and *d* become, whilst the wires *b* and *c* remain practically unaltered in temperature, and consequently in length. A pointer made of insulating material connecting the junction of *a* and *b* with the

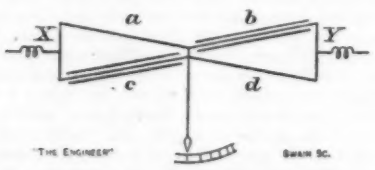


FIG. 10—MODEL OF A WHEATSTONE BRIDGE

junction *c* and *d* will move to the right if extended above, as the velocity of the wind increases.

The only alteration that is necessary in order to make the apparatus work with a change of resistance with temperature is to replace the pointer connecting the junction of *a* and *b* to that of *c* and *d* with a sensitive voltmeter or galvanometer, when the arrangement constitutes the well-known Wheatstone bridge. In both the mechanical and electrical model it is obviously essential that the current passing through—or the voltage applied to the bridge—be maintained constant, as variations in those quantities seriously affect the indications of the pointer in the mechanical model, and the voltmeter in the

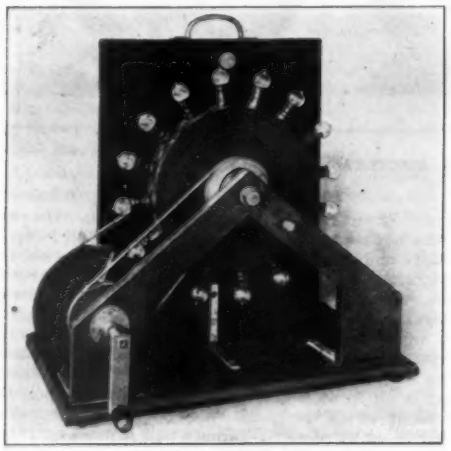


FIG. 11—ROTATING MAGNETIC FIELD MODEL

electrical arrangement. The necessary constancy is, however, easily and accurately obtained by a simple device now incorporated in the anemometer as manufactured by Messrs. H. Tinsley and Co. The difficulty of employing the mechanical method in an anemometer would, of course, be that the changes in length of the wire with changes of temperature would be too small, but the mechanical analogy serves to help non-electrical people to understand the general principle.

A model has been designed by the Metropolitan-Vickers Electrical Company, for the purpose of demonstrating the action of a rotating magnetic field, such as that which exists, for example, in the armature of a rotary converter, and it is illustrated in Figs. 11-13. The model comprises a number of electric lamps arranged around the periphery of a disc, which is given a rotary motion by means of a handle through the wheel B and a belt drive. The lamps are connected to the segments of a commutator D, attached to the disc.

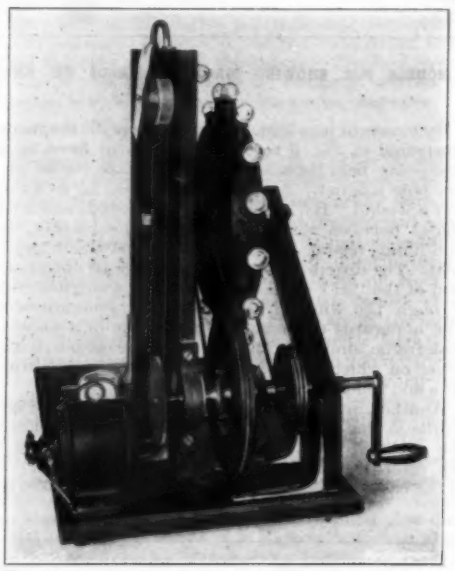


FIG. 12—SIDE VIEW OF ROTATING MAGNETIC FIELD MODEL

A revolving brush makes contact with the segments of the commutator, and is mounted upon a wheel C, which is driven from a differential gear by means of wheel A at a speed which is the difference in speeds

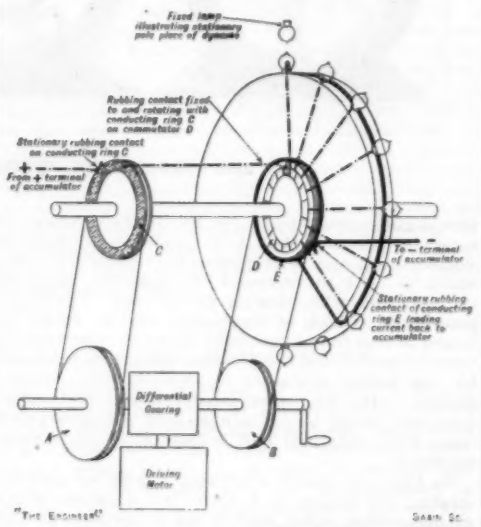

Fixed lamp illustrating stationary pole piece of dynamo
Rubbing contact fixed to and rotating with conducting ring C on commutator D
Stationary rubbing contact on conducting ring C
From + terminal of accumulator
To — terminal of accumulator
Stationary rubbing contact of conducting ring E leading current back to accumulator
Differential Gearing
Driving Motor
"THE ENGINEER"
SWAIN Sc.

FIG. 13—ARRANGEMENT OF ROTATING FIELD MODEL

of the disc and of an independent motor drive. The lamps on the disc are lit up successively as the brush passes over the segments of the commutator. Thus, when the motor is running and the disc standing still, a spot of light, representing, say, the north pole of an armature, appears to travel around the disc as the lamps light up successively, at a speed corresponding to the motor speed. As the disc is revolved in the appropriate direction, the speed of the revolving brush is reduced, and consequently the speed of the spot of light is reduced, until, when the motor drive and disc are running at the same speed, the light spot is stationary. A fixed lamp is provided to indicate the north pole of the field magnet of a machine.

The machine demonstrates how the magnetic field of the armature of a rotary or other synchronous machine revolves at a certain speed, while the armature is still, and as the armature comes up to speed, the field gradually becomes stationary. It is also rendered obvious how, although the speed may be synchronous, the machine may be out of phase. The model provides a striking illustration of a rotating magnetic field, and particularly of what occurs during the starting up of alternating-current machines, and it could be used for such illustrations in technical schools with great advantage.

Mining and Metallurgy in Sweden.

By JOHN G. A. RHODIN, F.I.C.

No. II.*

WHEN the nineteenth century opened Sweden was in a position very much like that during the last war, although she eventually got dragged into the Napoleonic Wars. The closing of the continental market made the intercourse with England more cordial than ever in history before or since. Political friendship did not, however, prevent a commercial war in the iron trade. The puddling process† of making wrought iron had been invented in England, and was developed against a Swedish competition which threatened to extinguish it, when in 1806 a protective tariff of £4 10s. per ton, £5 10s. in 1811 and nearly £6 10s. in 1816 was introduced. By this means puddled iron got an advantage of nearly £10 a ton in 1817, when Swedish iron, plus duty, sold at £24 a ton as against £14 to £14 10s. for English puddled iron. This apparent advantage of puddled iron was counteracted by the peculiar property of Swedish Walloon iron to make crucible steel less liable to lose its nature by repeated heating and cooling, a property called the "body" of the iron, which is still waiting for a satisfactory explanation. Hence, up to quite modern days, the annual output of Swedish iron increased, though with gradually smaller increments, the maximum of 270,000 tons being reached in 1885. Sheffield crucible steel continued to be made almost exclusively from Swedish iron, which maintained its high quality. A contributing factor was Jernkontoret, or the "Iron Office," an institution so peculiarly Swedish that it is worthy of a short description.

For some reason or another there is a tendency in Sweden to prefer the translation "Swedish Ironmasters' Association," which it no doubt is, but with important additions, making the "Iron Office" the official head of the industry, in spite of its being a private undertaking. It was formed in 1747 to regulate prices and to assist members with loans at 4 per cent. up to seven-eighths of the value of iron deposited in one of the Offices, depositories called "Jernvag," or literally "iron scales." This had the natural consequence that the "Iron Office" took good care that the quality was up to the mark. As the institution pays no dividend, its funds accumulated, and it undertook organised research and appointed an official inspector of blast-furnaces as early as 1751, the first being the already mentioned Sven Rinnman. In 1817 it started a periodical journal *Jernkontorets Annaler*, and it now keeps a staff of advising engineers, and supports mining and metallurgical schools and colleges. Hence it is essentially not a "masters'" association, formed to combat trades unions, as understood in England, and "Iron Office" suits it down to the ground as an appellation. This particularly Swedish institution has so often been the *deus ex machina* to Swedish investigators that it is impossible to make a fully satisfactory explanation of its importance, as it has been and is taken as a matter of course.

I shall now proceed to give a short description of the methods used in making Swedish wrought iron. Metallurgically, all these methods since the "Osmund" iron period, are one and the same, viz., oxidation of carbon, silicon and manganese in cast iron by charcoal and impinging blast in an open hearth. The differences lie in the form in which the cast iron is used, in the nature of the slag, in preheating or otherwise, roofing in of the hearth, &c. All the processes involve working the charges with iron bars and thus heavy labour, and all require great skill and judgment. There are four processes in all—

German forging Lancashire forging	} Cast iron as pigs or ingots
Walloon forging Franche-Comté forging	} Cast iron as cast bars (Swedish, *göa*)

"*German Forging*" consisted in melting down pig iron of the light grey variety in a somewhat deep open hearth with a highly silicious slag, working it to a pasty condition, "breaking it loose" from most of the slag, and reheating it in the same furnace for welding and hammering. The furnace had only one

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† Patents, Henry Corth, 1784, and William Parnell, 1787.

tuyere. The process was discontinued first, and it survives in improved form as—

"*Lancashire Forging*," which consists in melting down pig iron of special quality after preheating in the flue gases in a covered-in open hearth, with one, two or more tuyeres, working it with iron bars, "breaking loose" and welding and hammering or rolling with the aid of reverberatory "welding" furnaces. The hearth to-day has two, three or more working wells.

"*Walloon Forging*" consists in melting of the end of a heavy cast iron bar in the first part of a double hearth, with single tuyeres, working it there, "breaking loose" and heating for "welding" in the second half.

"*Franche-Comté Forging*" is a modification, using one hearth only, but in Sweden it took the form of working cast bars in the Lancashire forge.

To enter into further details would hardly be of interest to English engineers, as we can see that, apart from the Lancashire process, there is little to choose between the others. With properly skilled men, trained to use either process, equally good iron can be and has been made. Sweden has superabundance of charcoal and pure ores, but Swedish wrought iron owes even more of its purity and even quality to the skill of the metallurgists smelting the pig iron and to the skill of the "smiths" in the Lancashire and Walloon forges. This skill is, to all intents and purposes, inherited and traditional, and neither text-books nor records of any kind can impart it. There was no reason why puddled iron made in England and elsewhere, with good coal for the reveberatory furnaces, should not have been as good as Swedish iron, except that the race of "smiths," in the Swedish sense of the word, became extinct through the wasting of the forests under Charles I. The specific difference between the microscopic appearance of English puddled iron and Swedish "Lancashire" iron is caused by the larger quantity of "hammer slag" (Fe_3O_4) left in the former and its more uneven distribution, which points to less careful working only, and not to an inherent inferiority of the process.

With regard to the processes for making wrought iron from cast iron or "freshening" of the latter, as it is called in Sweden, E. Westman, the inventor of the well-known desulphurising roasting furnace, gave the following figures for work in the same district in 1867 :—

	Per ton bar iron. Kilos. pig iron.	Hecto-litres charcoal.
With Walloon forging there were used	1274	211
With Lancashire forging, with reheating hearth	1279	119
With Lancashire forging, with reheating furnace and hammer	1295	107
With Lancashire forging, with reheating furnace and rolls	1261	93
With German forging	1203	215
With Franche-Comté forging	1192	150

In the case of the last mentioned process, I wish to reiterate that it was carried out in the Lancashire hearth. From these figures it will be easily seen that the Lancashire process involves, as might be expected, the greatest economy of fuel. To-day it survives alone, together with a few Walloon forges, the iron from which is unequalled for making the very highest quality of steel. The Lancashire method was introduced into Sweden by Gustaf Ekman, who also introduced rolling of blooms, instead of hammering, and, furthermore, constructed a reheating furnace, burning sawdust and the like. To-day, the Swedish Lancashire [*sic*] furnace is a rather elaborate, semi-mechanical furnace, with three working wells, or maybe more, and charges up to 3 cwt. The consumption of charcoal is less than the figures given above. In giving this explanation, I have felt slightly amused by having to write the word "Lancashire" so many times, but, thanks to judicial perspicuity and maybe sense of humour, "Lancashire" iron is legally Swedish wrought iron, made with charcoal! But what is there in a name? There is a Dannemora Ironworks in Sheffield as well!

To engineers, Swedish wrought iron and Swedish export pig iron are the most reliable irons obtainable. The wrought iron, in particular, has a most remarkable power of withstanding alternating stresses and corrosion. Its tensile strength is comparatively low, but its ductility cold is phenomenal, and it has no "rotten" temperature between cold and white heat. It welds incredibly easily, and used as a filler of electric or oxy-acetylene welding, it makes welds which may be doubled flat on themselves cold without cracking.

The making of wrought iron in Sweden is threatened, but it survives, and it is the sincere hope of all Swedish metallurgists that there will always be buyers for a material in which all the properties desired in soft iron are more perfectly attained than in any other product including the next best—Swedish extra soft Martin steel. In one direction this wrought iron is a scientific puzzle, viz., its melting point is higher than that of any other pure iron. I made a number of oxy-acetylene and electric welds some years ago with wires, distinguished by numbers, the significance of which was only known to me and an independent witness. The welders in every case picked out the Swedish Lancashire iron as the best, because the welds ran "thin" and uniform, *i.e.*, the surface of the pieces to be welded "ran" with the iron, the temperature being high enough. One of the other wires was a Swedish Martin steel of even greater purity, both kinds containing over 99·85 per cent. iron. I have compared the powers of these two classes of wire to withstand atmospheric corrosion by leaving them exposed for over six years in my laboratory. The "Lancashire" iron is absolutely unaffected, but the Martin steel shows a slight inclination to pitting. A control sample of a proprietary pure brand of iron, lying side by side with these, is covered with rust from end to end. The explanation lies in the property of Swedish iron to cover itself with a protecting coating of black oxide. This tendency to "black rusting" is shared by Sheffield crucible steel made from Swedish iron. I have got a mason's pointing spatula, made in Sheffield some sixty years ago, which I have used, or rather ill-used, since some years before the war; it was given to me by Messrs. Cubitt's master mason, who was then a white-haired, silk-hatted gentleman and had used the tool from his young days. To-day this old tool looks like being made of ebonite without a speck of red rust. The trade mark is almost obliterated by wear, but the word "Sheffield" can be made out. There is a fond belief in a corner of my mind that Sheffield tool steel makers will think twice before they dissolve the partnership with Swedish iron altogether—when my relic was made it was fairly exclusive.

Steel Manufacture in Sweden.

As I have shown before, steel has been made in Sweden since the beginning of things, but up to the eighteenth century only as an incompletely "freshened" wrought iron. Certain manganiferous ores were called "steel ores," and the first document in the trade, 1303, speaks of "iron and steel mountains." In these days one must admire the empirical skill and power of observation which unwittingly singled out manganiferous ores for making good steel and bad iron. It is, however, obvious that steel made by the "Osmund" and other early processes left a lot to be desired with regard to the even qualities of articles produced, a fact which is emphasised by the reputation of famous swords, &c. When Rinman caused the English secret of making steel by cementation to be "annexed," that feeling of dissatisfaction with the native product must have reached a climax. The steel made then by forging cemented bars contained 0·66–0·70 per cent. carbon and attained a fair degree of perfection. Crucible steel with higher contents of carbon introduced as cast iron in the mixtures was not made in Sweden to any great extent, although the process was known and tried in the eighteenth century. The history of steel as ingot metal is fearfully complicated, and makes unpleasant reading in our time. Metallurgy was in those days a business or trade and not a science, hence an element foreign to any calm discussion—"competitor's envy," a Royal disease—was made to formulate history.

To complete my story I must touch the Bessemer process, but with Livy I must preface that I do not feel like doing it. The facts are simple. Bessemer invented a process, which he patented in 1855, and shortly afterwards built the first stationary converter. His priority as inventor has never been disputed, but he never succeeded in working it till it was taken up in Sweden by G. F. Göransson, who bought one-fifth of the Swedish patent after seeing Bessemer in England in the spring of 1857. Bessemer had failed through insufficient air supply to the tuyeres, and by using eleven instead of six tuyeres, and making their diameter ¾in. instead of ⅝in., Göransson succeeded in making charge after charge of easy-running good steel, free from slag, on July 18th, 1858, at Edsken, in Sweden. Such are the facts in a nutshell. The bitterness felt amongst Swedish metallurgists is caused only by the omission on the part of British writers even to mention Göransson's name in this connection, as the process there, as here, is called after Bessemer, and there it rests. To turn to the more pleasant side of the case, it deserves to be widely known that Swedish Bessemer steel is mainly of the high-class variety, including tool and razor steel, which was the case here to begin with, when Swedish pig iron was used after melting in reverberatory furnaces. It was, however, discontinued soon to make English Bessemer into cheap structural steel, an utterly impossible thing with the dear Swedish pig iron. How the Siemens-Martin process eventually ousted all other steel processes in Sweden as elsewhere is a matter which belongs to the world's metallurgical history, but to-day a new departure has been made there, the thermo-electric production of both pig iron and steel. Statistics for the output 1917 give :—

	Tons.		Tons.
Pig iron	830,000	Martin steel	500,000
Of which for export	192,000	Bessemer steel	78,000
		Electro steel	7,300
Leaving for conversion	638,000	Wrought iron	115,000
			700,300

The excess of products indicates the amount of scrap used, as no imported pig iron is employed except for foundry purposes.

From this brief survey it will be seen that through the activity during the nineteenth century Sweden became mainly a steel-producing country with wrought iron as a side issue instead of the mainstay, as in olden times. As comparatively little structural steel is made, Sweden is a formidable competitor in the world's market for high-class steel as well as iron. This change was brought about by the work of Swedish chemists, who had almost only the national iron industry as a practical issue to which to devote their energy. It does not matter, where you visit an ironworks laboratory to-day, the methods used are mainly of Swedish origin like the filter paper employed. First and foremost stands J. J. Berzelius (1779–1848), to whom the world owes accuracy in chemistry as to no other. How many chemists know, however, when burning an ash-free filter paper, that they owe that very simple process to him? Without that method, accurate determination of silicon and sulphur in steel would be impossible, and he used it for both, though it was taken as a matter of course. He also introduced the standard method of determining total carbon in steel by dissolving the samples in ammonium cupric chloride. His countryman, Eggertz, invented the colorimetric method used universally for determining combined carbon rapidly, and another, Ullgren, the method of combustion with a mixture of sulphuric and chromic acid. Rapid colorimetric testing for sulphur owes its existence to yet another Swede, Wiborgh, of pyrometer fame. Sefström's and Eggertz's methods of determining suitable slags for iron ores by dry assay came from the same country. The use of molybdic acid for determining phosphorus goes back to Scheele, &c. &c. Berzelius internationalised the use of the blow-pipe for analytical purposes, but the method was introduced into mineralogy by Swab already in 1738. Bergman's pupil, Gahn, further developed the method. I suppose a Scotchman would be surprised, but Gahn is a corruption of Colquhoun, and our chemist belonged to a Scottish family settled in Sweden during the Thirty Years War. Another member of that ilk, Dr. Henrik Gahn, discovered the use of boric acid as an aseptic round about 1860, even patenting the word "aseptin" in that connection, showing how the ubiquitous Scot appears before his time even in Sweden.

It may not be strange after all, but Berzelius made chemistry a favourite study in Sweden a hundred years ago, as Linnæus made botany a century earlier, not through inspiring a desire for gain, but mainly one for glory. Hence the Swedish ironworks have never since been lacking scientific assistance apart from that afforded by the "Iron Office." What they did in the way of experimenting I do not know, but I have a Swedish book before me, dated 1873, which mentions manganese, silicon, silver, nickel, rhodium [*sic*], and tungsten steel. A steel with 5 per cent. tungsten was made in Austria in 1856, and is described as harder than "the best English crucible steel." Both tungsten and nickel steel were, however, tried very early in Sweden, apart from appearing in literature, and I am afraid that many inventors on both sides of the Atlantic would be surprised if they knew what is to be found amongst dusty old records in that country alone. For our purpose it is sufficient to note that all processes worked in the Swedish iron and steel trade have been studied down to the minutest detail by capable men before entering as competitors in the universal market. The modern steel works in Sweden do almost incredible things, amongst which I will mention the little known fact that the Bofors celebrated 30 cm. cannon are machined directly from *castings* of nickel-chromium steel.

All these modern works, which now are the pride of the Swedish ironmasters, and which no doubt will be shown to visitors, are, however, so much of a muchness with modern English works that the essentially Swedish characteristics are missed unless they are specially looked for. They lie in the materials worked, not in the machinery. Progress is in one sense a melancholy thing. During the nearly thirty-five years of my stay in England I have paid fairly regular and numerous visits to Sweden, and the changes from the old, almost aboriginal country I left, into the hyper-modern country of to-day are not at all pleasing to me. As late as 1901 I was able to take some English friends to see an ancient nail forge with an antiquated "whip-hammer," driven by a water-wheel. Inside, a master smith, two strikers and a boy were forging ¾in. nails! They drew them out from 1¼in. bars at the rate of perhaps a dozen a minute, so great was their skill. By the side of the forge there was a transformer pillar marked with skull and crossbones, converting 10,000 volts for lighting the old survivor! To me the scene represented the spirit of the Norse fighting the last fight against progress, just able to lift his arm for a few last blows. My English friends were almost thunderstruck and watched the scene for a very long time in dead silence, whilst the heap of nails on the floor grew in dimensions. This was at Motala, within reach of Stockholm, during a half-day trip. As Swedish hand-forged nails are still to be had under the name of "Norway nails" (!), there must be some old forges still left, which should certainly interest the members of the Iron and Steel Institute more than the steam hammer and hydraulic forging presses, which are to them as commonplace as the English lakes are to a Swede. Both sides, however, feel insulted if you mention these things. In judging the modern Swedish iron and steel industry its apparently small magnitude grows almost gigantic, if you consider that the total population is less than 6,000,000, and that 8,000,000 tons of high-percentage iron ore are raised

annually, of which unfortunately 6½ millions are exported as such.

Iron Ore Mining.—The industry described so far is centralised in what is wrongly called the middle part of Sweden, as it is far more to the south, but there are enormous deposits of iron ore in the Arctic region, which are now worked in the most up-to-date fashion. These deposits have been known for a couple of centuries, but they have only been worked since the last decennium of the nineteenth, being inaccessible before. The two largest mines are Gellivaara and Kiirunavaara, which are veritable mountains of magnetic iron ore. They are approached by railways, crossing a wilderness reminiscent of Northern Canada. Everything devised by modern science for the purpose can be seen at these mines, which are worked with every consideration for economy and safety. As a scientific point of interest I may mention that these mines have been surveyed by the magnetic method, invented by the late Professor Robert Thalén, of Upsala, whose fame in connection with spectral analysis is world-wide. It consists in observing the deviations of both the horizontal needle and the dip needle, caused by the deposits, choosing the position for observations according to a fixed plan, thus investigating the intensities of the field surrounding the ore. This was the pet hobby of the venerable old professor in my time at Upsala, when we used a squared blackboard as a "district" and a hidden magnet as the deposits. This artificial district has now sides of many miles! The two mines under discussion yield some 60 per cent. of the total Swedish output of iron ore. It is unfortunately rich in phosphorus, and hence useless for essentially Swedish iron. Some ores like that from Tuolluvare are, however, as pure as those from Central Sweden and are used for thermo-electric pig iron smelting. The bulk of the northern ores is, however, exported, and Germany is largely dependent upon that source of supply for her basic processes. Whether this anomaly will eventually be corrected by further developments of thermo-electric processes remains to be seen. In connection with these mines there is another at Grangesberg, in Central Sweden, which also yields phosphoriferous ores, and the three are combined in a financial group of international importance. This latter mine has caused a certain amount of coke iron smelting, which so far has not put the national charcoal iron into disrepute.

Charcoal.—As the Swedish iron industry rests on charcoal smelting, it is only natural that the iron smelting works are large owners of forest, which was originally a *sine qua non* for their operations. The Uddeholm Company, for instance, owns round about 282,000 hectares of forest, or approximately 700,000 acres, or nearly 1100 square miles. The ancient "Kopparberget" goes one better, with 350,000 hectares, or nearly 1,000,000 acres. It is, of course, almost impossible for a stay-at-home Englishman to realise what a big forest means, but I remember once being on a shooting expedition in one of a paltry 150,000 acres—not far from Uddeholm—for a fortnight, without ever getting out of it. The "roads" are paths for timber and charcoal wood drays, which are used in summer on the slippery grass as well as on the snow in winter. Where charcoal is burnt there are open places on the slope called "coal-bottoms," and you generally find your way by the trees being marked, birch with black rings and pines with white ones, by the surveyors to indicate border lines. These are called "row gangs," which a Scotchman would understand. These "woods" are patrolled winter and summer by keepers, most of them in Government service and called "crown hunters," a sturdy race in picturesque uniform, who are as useful in war as in peace time. It is a land inspiring a more or less poetic feeling, and the national "skald," Tegnér, wrote about a journey in amongst the trees :—

> "The forest everywhere, engirdling all to see,
> Stands high and serious, just looking down on thee."

I apologise for possibly misrepresenting a classic in my endeavour to render his words as far as possible verbatim, but, as he said, these forests seem to look down on mere man as a puny intruder. Yet man has made Forest his servant, and to-day he is the result of man's work, being rationally re-grown. Forestry is a great industry in Sweden, and though charcoal burning is, by far, not the main thing, yet I believe that in no other country is that article produced in such quantities. Apart from burning in mounds, there is a great amount of charcoal produced by wood distillation, which also yields valuable products, like acetic acid, acetone, methyl-alcohol, tar, &c. &c. All the ironworks are also large makers of wood pulp, mostly by the sulphite process. A curious by-product is ethyl alcohol, of which Kopparberget alone produces 1,450,000 litres, or some 320,000 gallons per annum. When the Inland Revenue in Sweden gets "sober" enough to set this source of motor spirit free in the market, there are hopes of further development. The enormous production of wood pulp in Sweden is outside the present subject, as is the timber trade generally, but the above notes will show that the old iron industry is an important factor governing that business as well.

Railways, &c.

I have already pointed out that railways have been built in the north to tap the mines there, and the same was the case in central Sweden years ago, when "Bergslagens" Railway was built to facilitate the transport of ore to Gothenburg from all the mining districts. There is also transport by canal from Lake Wenern to that city by sea-going vessels up to 2000 tons burden. The ore shipping goes *vid* Lulea on the Gulf of Bothnia and Narvik in Norway, and to some extent from Oxelösund by the Baltic a distance south of Stockholm. This trade has created a special type of self-trimming steamers with numerous masts, two and two abreast, each with one or more crane booms. To a sailor they are an abominable sight, and I heard a captain call them a bit of pine-forest on the briny, when seeing one on the North Sea on her way to Rotterdam, the usual port of discharge. The loading at Lulea is carried out by means of huge cantilever swing-out cranes, swinging the wagons out for tipping. These were made by the American Westinghouse Company, a somewhat humiliating precedent to the present carrying of coals to Newcastle.

Engineering in Sweden.

It is only natural that a country like Sweden should have a fairly developed engineering industry. As a matter of fact, it is just only respectable, everything taken into consideration. To an English reader, it might be interesting to know that it depended first upon English, and then upon English and German competition in combination. Sweden produces and exports almost exclusively expensive specialities, amongst which fast-running machines, like separators and steam turbines, oil engines, heavy alternators, ball bearings, cannon, steel castings, wood-working tools, &c., are known almost everywhere. Shipbuilding is of importance, but most of the Swedish tonnage is imported, and so are motor cars, mainly represented by Fords and German war vehicles. Locomotives and agricultural and other implements are beginning to go East. To my mind, the situation is unsatisfactory, as highly skilled engineers leave the country, which can ill afford to lose them. War conditions caused the establishment of a lot of enterprises for making precision tools and gauges. They are now in a precarious position, and people over there are not free from anxiety with regard to better times coming—the sooner the better!

In leaving my subject, I am sorry that I have been able to do not more than merely touch many important things; but the field is too wide, even for a moderately sized book, let alone a couple of articles. My hopes are, at all events, to have shown that iron and steel are part and parcel of the Swedish national life as the ores are of the country. Perhaps there is a bit of the toughness of its iron in that small nation, which maybe has grown greater by political misfortune than ever before, and which is still a free people, endeavouring to face whatever future may bring, with earnest effort to do its best.

SIXTY YEARS AGO.

While in the Prusso-Austrian War of 1866 the victory on land went decisively to the Prussians, neither on land nor sea could the Italians, allied with Prussia for the recovery of Venetia, prevail against the Austrians. In the end they obtained Venetia, but it was as a result of the Prussians' victory at Königgrätz, and in despite of the Italian defeats at Custozza, Monte Suello and Lissa. The battle of Lissa was something of an old-fashioned sea fight. Except for the fact that the vessels taking part in it were driven by steam and, in some cases, were armoured, it might have been one of Nelson's battles or even one of Drake's time. The ships on both sides went into the engagement with their gala flags hoisted. In a dense atmosphere of steam and powder smoke, there was a confused struggle in which cannonading at close quarters, ramming, boarding, and the throwing of incendiary hand grenades put to the test and shattered many of the combatants, and many a theory of naval construction and action. Writing in our issue of August 10th, 1866, we endeavoured from the diverse but as yet disjointed information available at that date, to piece the engagement together and to draw what lessons we could from its course and outcome. Admiral Persano, on the Italian side, had under his command on the day of the battle eleven ironclads, an ironclad cupola ship, two steam frigates, four wooden screw frigates, one wooden screw corvette, three paddle corvettes, four dispatch boats, four gunboats, and two transports. On the Austrian side, Admiral Tegethoff had seven ironclad frigates, seven wooden frigates and corvettes, one sloop of the line, and eight dispatch boats and gunboats. The Italians had been endeavouring to take the forts on the Island of Lissa when the Austrian fleet descended upon them. Each fleet went into action in two divisions, the ironclads in the front and the wooden vessels behind. The Italian Admiral sent some of his ironclads through the Austrian first line to attack the wooden ships in the rear, and by so doing exposed the remainder of his ironclads to a dashing attack by the Austrian's first division. Of the Italian ironclads the Palestro was speedily set on fire by the Austrians' hand grenades, and the Re d'Italia, her rudder rendered useless, fell a prey to the enemy's rams and was sunk. The fight continued for some time afterwards, but eventually the fleets with a final cannonading broke away, the honours going with the Austrians. Amidst all its old-time incidents the battle foreshadowed at least one modern development, and we did not fail to emphasise it. The armour of the Italian ships preserved the vessels from the Austrian shells, but on at least one Italian ironclad, the Re di Portugallo, the fumes from a shell which struck and broke near a porthole entered the enclosed and confined space where the guns were being served. For some minutes the men were prevented from working the guns. From this incident we drew the lesson that since it was comparatively difficult for shot to pierce modern armour, recourse might be had to shells containing compositions which would at least temporarily drive the enemy from their guns, thereby affording an opportunity for the fate of the battle to be decided.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

"RAILWAY MATTERS."

Sir,—In the issue of The Engineer for July 30th, in the "Railway Matters" column, you give some interesting information regarding the accident to the "Flying Dutchman," at Long Ashton, near Bristol, in July, 1876, when the B. and E. tank engine 2001 jumped off the road.

This engine and 2005 only a few days before the accident had gone down to Bristol from Swindon, where they had received their first overhaul by the G.W.R., and had also been re-numbered. Wm. Dunscombe, who was killed in the accident, was the driver of 2001, and my father was the driver of 2005. The day before the accident Mr. Dunscombe remarked to my father that "his engine was riding very badly, and that she would either have him up in the hedge or down in the ditch." Mr. Dunscombe was used to these engines, as he was an old B. and E. driver, so no doubt there was something unusual in the behaviour of 2001. My father kept the above to himself for several years, when he told me about it, although I remember the accident and my father driving 2005, but was very young at the time. It was thought by the B. and E. engine fitters, who built these engines and overhauled them for several years without any accident happening to them, that the axle-boxes of the bogies had been fitted too tightly in the horns at Swindon.

In view of the remarks made shortly after the accident, in The Engineer and by the Government inspector, regarding the very heavy load of 18½ tons on the driving wheels of these engines, and consequently the ill-effect on the permanent way, it may interest you to know that the G.W.R. increased the counterbalance weights by about 200 lb. in each driving wheel, partly to balance the reciprocating masses, the B. and E. R. having apparently only balanced the revolving masses, leaving the weight of the extra large bunker and tank behind the footplate to check any disturbance from the reciprocating masses; and these engines, so balanced, rode exceedingly well. This additional weight in each driving wheel would increase its load on the permanent way from a practically steady load of about 9½ tons to a varying load, with a maximum of about 13 tons, when the engine was running at 60 miles an hour.

Wm. Hy. Robson.

London, S.W. 16.

EMPIRE TRADE.

Sir,—The following is an extract taken from a letter which I have just received from New Zealand, and in view of the expression contained therein I think it may prove of interest to your readers :—

"In passing I would mention for general information that direct representation is what is required out here to compete successfully with the American methods of sale. Two or three British motor car manufacturers and others have adopted the method of establishing their own offices and representatives out here with some considerable success. I am keenly interested in trade with the Empire, and home firms would do well to cater for colonial markets before the American gets too great a hold to be unseated without great effort and expense. This applies especially with the motor trade.

"The percentage of imports from England by New Zealand is on the increase, and the Americans are realising it and putting forth greater efforts to retain their hold, even to the extent of erecting assembly shops out here. I hope that we shall see determined efforts to capture our trade on the part of British manufacturers. As a unit of the Empire we should buy within the Empire to increase its greatness, but there should be far greater British representation out here than there is to enable us to do so. I for one would dearly love to see an organised endeavour to capture our market, made by British manufacturers. Many New Zealanders have the same views, and I think it does well to circulate these views and keep the Empire spirit strong."

This extract is by no means an isolated case, but only expresses the same views which I have received from time to time in other letters from various parts of the Empire, all of which are urging the home country to make greater efforts in connection with the Empire trade.

Arthur W. Farrer.

London, S.W. 1, August 6th.

FULL CYCLE.

Sir,—It is somewhat astonishing to read in Mr. Stanley P. Christie's letter in your issue of July 23rd that there are "but three real 'producers' in the whole of industry: the farmer, the hunter, and the fisherman."

It would seem that the miner might be given some courteous recognition, even if we can only see him in the primitive *rôle* of seeking for flints and shaping them into forms that will help his hunting and farming friends.

It may be that Mr. Christie feels that the miner should be ignored as being merely the exploiter of an exhaustible resource. As a matter of fact that phase of the situation may well give him concern. As long ago as 1916 (*Engineering Magazine*, February, 1916) I expressed the view that the decline of civilisation would probably come from the exhaustion of its mineral resources and that we were likely to see bigger and better wars in the future over their control.

Donald M. Liddell.

Seville, Spain, August 5th.

It has now been announced by the London Electric Railways Company that the extension of the City and South London from Clapham Common to Morden and of the Charing Cross, Euston and Hampstead from Charing Cross to Kennington—where a junction will be made with the City and South London—will be opened on Monday, September 13th.

Railway Matters.

THE Derwent Valley Railway Company, which possesses 16 miles of line in the neighbourhood of the city of York, will cease to carry passenger traffic after the 31st inst.

AUTOMATIC signals of the three-aspect day colour light type are to be provided between Capetown and Wynberg so as to allow the train-carrying capacity to be increased.

THE whole of the 800 miles of railway, 637 of which are double track, of the Southern (U.S.A.) Railway from Washington, D.C., to Birmingham, Ala., have now been equipped with day colour-light signals. It is said to be the longest continuous installation of such signals. They are operated by alternating current, fed from a power transmission line of the same length.

THE earnings of the Canadian National Railways have been substantially increased during the present year. According to a statement just issued, the gross earnings for the first six months of 1926 amounted to 120,989,008 dollars, as compared with 105,543,743 dollars in the first half of 1925, an increase of 15,445,265 dollars, or 14·63 per cent. The net earnings were 14,856,660·52 dollars, compared with 3,742,345·83 dollars, and the operating expenses 106,132,347·47 dollars, as against 101,801,397·17 dollars. The net earnings for June were 1,941,077·66 dollars, compared with an operating deficit in June, 1925, of 432,376·12 dollars, a betterment of 2,373,453·78 dollars.

IN view of the industrial situation since the beginning of May, the following figures, published by the Railway Companies' Association, as to the financial results up to the end of April will be of interest. There were, when compared with the first four months of 1925, increases all round, which included:—Number of passenger journeys, 7,400,199; receipts from passenger fares, £102,386; tonnage of general merchandise, 352,463; tonnage of coal, coke and patent fuel, 2,764,290; freight traffic receipts, £1,058,069. In contrast to the foregoing the passenger receipts of the four grouped companies had a decrease of £5,580,000, and the freight receipts a decrease of £9,945,000 for the twenty-nine weeks up to July 25th.

As until the Kent coalfield became productive the Southern Railway Company had no mineral traffic originating on its line, there was no occasion for it to include in its rates and charges the requirement to be found on all other lines, except the former North-Eastern, that traders must find their own wagons for coal and other Class A traffic. When, however, wagons became necessary in the Kent coal area, the Southern provided what were required, and refused to accept those privately owned. A complaint was therefore lodged before the Railway and Canal Commission, which has now decided by a majority that the railway company's attitude was correct. It is important, though, to note that the dissenting member —of the three who form the Commission—considered that it was the refusal of a reasonable facility. That would be a question of law and not of fact, and therefore the decision of the Commission is open to appeal.

SATURDAY last, the 7th inst., was the fiftieth anniversary of the collision at Foxcote, near Radstock, on the Somerset and Dorset Joint Railway. Two special passenger trains met head-on on a single line, and twelve passengers and a guard were killed. The line was controlled by crossing orders, and whilst a time-table had been provided for the down train, nothing had been arranged for the up train. The stationmaster relied, however, on the promise of the crossing order controller that he would deal with the matter, and allowed the up train to depart. That collision, following on the more serious one in September, 1874, at Norwich, led to the late Edward Tyer inventing the single-line tablet system, wherein no train was allowed to be upon a single line without a tablet; the tablet could only be obtained from its instrument with the co-operation of the signalman at the opposing end of the section; the issue of a tablet locked up both men's instruments until the tablet had been taken through the section and inserted in the instrument at the other end.

IT was mentioned in this column on July 24th last year that the Southern Railway Company intended to replace the overhead electrical equipment on the Central, or former Brighton, section by the third-rail method. It is now officially announced that that is to be taken in hand forthwith, and that will make the electrical system in use on the Southern uniform. It is also proposed to equip for electrical traction those lines in the London area which are now wholly worked by steam. Those include the line between Streatham Junction and Epsom, *viâ* Sutton, from Sutton to Epsom Downs, Streatham Junction to Wimbledon, London Bridge and Norwood Junction, Herne Hill and Tulse Hill, Crystal Palace and Beckenham Junction, Purley and Tattenham Corner, and Purley and Caterham. There will be 127 miles of overhead equipment to replace and 105 miles to convert from steam operation to electric traction. Those figures are exclusive of sidings. The cost will be about £3,750,000, and it is hoped to complete the work by the end of 1928. No mention is made of the Wimbledon and Croydon line.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the first six months of the present year was as follows, the corresponding figures for 1925 and 1924 being added in brackets:—Locomotives, £1,990,812 (£1,738,212, £1,115,254); rails, £1,143,706 (£993,411, £916,118); carriages, £1,125,050 (£797,437, £558,954); wagons, £1,743,908 (£1,628,261, £1,805,716); wheels and axles, £283,028 (£295,509, £338,857); tires and axles, £152,886 (£224,411, £332,285); chairs and metal sleepers, £561,625 (£377,475, £788,128); miscellaneous permanent way, £577,101 (£676,245, £652,556); total permanent way, £2,841,672 (£2,644,433, £3,144,144); The weight of the rails exported was 146,797 tons (103,953 tons, 102,218 tons); and of the chairs and metal sleepers, 57,931 tons (32,549 tons, 62,267 tons). During the month of June locomotives to the value of £498,441 were sent overseas, which included £203,119 for Australia, £104,029 for the Argentine, £46,800 for Ceylon, and £1975 for India. For the same month the total value of the rails exported was £152,239, which included the Argentine £61,615, India £16,965, South Africa £6119, British West Africa £3928, Ceylon £1333, and New Zealand £1110.

Notes and Memoranda.

THE average daily consumption of water in Melbourne is 58·28 gallons per head, while the sewage pumped amounts to 42·07 gallons a head.

IN early July the rainfall in Saskatchewan broke all previous records, when 0·95in. fell at Saskatoon in 40 min. During this period over one-sixth of an inch fell in 5 min.

IT is predicted by Dr. J. C. J. Bradfield that within twenty years another bridge will be required across Sydney Harbour, and that its site will be between Fort Macquarie and Kirribilli Point.

IT is claimed that the German trade ship Vaterland, which will shortly start on a voyage round the world, is the largest sailing ship in the world. She is a four-master of 2500 tons, and has accommodation for sixty-eight passengers.

TECHNICAL PAPER No. 15 of the Department of Scientific and Industrial Research, which has just been published by H.M. Stationery Office, deals with the carbonisation of Durham coal in continuous vertical retorts. In this report it is shown that the introduction of steam 3in. above the door casting of the retorts, instead of 2in. below the top of the coke chamber casting, increased the calorific value of the resultant gas from 503 B.Th.U. per cubic foot, up to 570 B.Th.U.

AMONG the various water storage schemes now in course of construction in Victoria, there are the Hume Reservoir, which will hold 1,100,000 acre-feet; the Sugarloaf dam will in two years' time hold up 306,000 acre-feet; and the Glenmaggie system, which now holds up 50,000, is being increased to impound 150,000 acre-feet to supply Sale and Bairnsdale. The Water Supply Commission has in contemplation other big works for conservation and irrigation purposes in various parts of the State.

A NOTE in the *American Machinist* by Mr. S. C. Sumner, deals with the care of ruling pens, and includes the following remarks: "Further, in purchasing a pen the fixed-blade type will give the best service. Opening hinges are by no means essential for cleaning, while they render a pen less convenient for handling, and are liable to become slightly loose. Sufficient opening is available on the fixed type when it is necessary, as it is sometimes, to remove a slight burr left after stoning on the point. The lightest touch is sufficient to effect this. Only a small oilstone is necessary, and it should be thin enough to pass between the fixed blades when the screw is removed."

COMMENTING on the trouble of oil pollution of navigable waters by vessels carrying oil fuel, the *Journal of Commerce* remarks that quite frequently ships at sea leave very clearly defined oily wakes from defective rivets, &c., which previously remained unsuspected. From such a source leakage might appear of very little moment, particularly in a moving ship, but actually it adds very appreciably to the amount of oil in the ocean, for the stream, if small, is continuous, and a very small quantity will form a film over a wide area. It has been shown that a pint of thick oil will form a film about an acre in extent, and this steady drip proceeds both at sea and in harbour until the loose or defective rivets are found and replaced.

EXPERIMENTS now being carried out by the National Research Council of Canada and the Department of Mines, Ottawa, indicate that the lime contained in Canadian magnesite is not detrimental in the manufacture of magnesite bricks. The experiments are designed to overcome the prejudice existing among steel manufacturers against Canadian magnesite, and efforts are now being made to develop a market in both Great Britain and the United States. The most important known deposits of magnesite in Canada are found in the Grenville district of Quebec. These deposits were worked on a large scale during the war, since which time Canadian production has been limited almost entirely to the home market, owing to the heavy import duty on magnesite entering the United States.

ACCORDING to an account printed in the *Engineering News-Record*, some experiments carried out at Illinois by Professors S. W. Parr and F. G. Straub, when soft steel is stressed beyond its yield point and is in contact with strong caustic soda solution, the metal is attacked by intercrystalline corrosion; it becomes brittle, and finally cracks and breaks. Both factors must be present; the action does not occur at stresses below the yield point or at low concentration of the alkali. The presence of strengthening alloy material in the steel—up to 3½ per cent. nickel, nickel and molybdenum, manganese ranging from 0·01 to 0·76 per cent.—had no effect on the action, except in so far as the yield point strength of the steel was raised by the addition. Phosphorus and sulphur had no noticeable effect in the ordinary ranges, but a high-phosphorus high-sulphur steel—percentages of 0·215 and 0·126 per cent.—showed marked acceleration of the rate of embrittlement. Cold working of the metal had no distinct effect.

THE production of natural gas by the Ontario wells during the year 1925 was 7,040,565,000 cubic feet, according to the annual summary of natural gas statistics issued by the Government of Ontario. The gas was valued at 3,888,397 dollars, that figure representing a decline of 187,607 dollars over the previous year, which represents a lowered production of some 330,349,000 cubic feet. The figures show that during the year 2115 wells, all situated in Western Ontario, had been supplying natural gas for domestic purposes. During the year 174 wells were abandoned by their operators and 140 new ones drilled, of which 118 had proved to be producing wells. The county of Essex was the leader in gas production, some 4,145,047,000 cubic feet having been obtained from its wells during the twelve months. The wells of Kent County yielded 126,687,000 cubic feet. The county of Haldimand was one of the largest producers, with a record of 1,548,658,000 cubic feet. Commenting on the figures, our contemporary, the *Canadian Engineer*, remarks that the lessened production from the previous year of 330,349,000 cubic feet was not altogether due to the lessened flow, although that was unquestionably a factor. Conservation, which was induced by higher rates in several localities, was also an important influence.

Miscellanea.

A VERY important drainage scheme, to cost Rs. 27,23,000, has been sanctioned by the Karachi Municipality.

THE present daily output of the United States of ammonia produced with atmospheric nitrogen is about 70 tons.

IT is proposed to construct a transporter bridge near the mouth of the Yarra River, Victoria. The span would have to be 500ft.

A SALT works is being put up at Bowen, Queensland. An output of 15,000 tons a year is anticipated from evaporating sea water.

THE eighth Model Engineer Exhibition will open on September 17th for one week, at the Royal Horticultural Hall, Westminster.

A SEAM of coal, known as the Red Vein, which is 4ft. 9in. thick, has been found in the Lower Cwmgorse Valley by the Trefor Company.

THE plant of the International Nickel Company at Port Colborne, Canada, is being increased to give an output of 1,000,000 lb. of electrolytic nickel a month.

A LARGE oil refinery for dealing with fish and cotton seed oil is to be put up at Harbour Grace, or Carbonear, Newfoundland, by the Terra Nova Oil Products Company.

A STATEMENT just issued by the Lincolnshire Boring Syndicate suggests that the Top Hard, or Barnsley, coal seam is workable throughout the county, at a depth of some 900 yards.

FLAX is being planted extensively in Natal, and it is proposed shortly to put up a decorticating plant and apparatus for the production of alcohol from the waste pulp from the leaves.

THE accident to the Cochin Harbour Board's dredger Lord Willingdon, which ran ashore in the Arabian Sea, resulted in a serious dent in the port bow, which will cost some Rs. 80,00 to repair.

THE new Dornier seaplane, which is being built at Friedrichshaven, is to be fitted with two 750 horse-power engines. It will accommodate two pilots, a wireless operator and twenty passengers.

THE new section of the soap works of the Co-operative Wholesale Society at Irlam, near Manchester, has just been opened. The weekly output will be 500 tons, making with the output of the old section of the works a total weekly productive capacity of 900 tons.

IT is recommended by the Gas Cylinders Research Committee of the Department of Scientific and Industrial Research that the periodical re-heat treatment of carbon steel gas cylinders which have not been obviously damaged serves no useful purpose, and should be discontinued.

THE importation of paraffin oil into Hangchow, China, has increased nearly three times within recent years. The advance is attributed to improved means of communication in the interior and increasing consumption of the oil by farmers, to whom it has ceased to be a luxury.

SOME unusually large castings were recently taken by rail from the works of the Darlington Forge Company for shipment to Sydney. They were the four bearings, each weighing over 300 tons, for the Sydney Harbour Bridge, and required seventeen special wagons for their transport.

ACCORDING to a recent report of the Bureau of Statistics, there are seventy plants in the Dominion engaged in the cotton textile industry, in which a capital of 60,209,854 dollars is invested. Approximately, 20,000 persons find employment in the industry, which has a production value of 30,289,131 dollars.

AN agreement between Hoskins, Ltd., and the New South Wales Government in relation to the Port Kembla–Moss Vale Railway and the Port Kembla Ironworks has been completed. At first the work is to be confined to the manufacture of pig iron, of which it is estimated 3000 tons a week will be manufactured.

CANADA, with 11.6 telephones to every 100 of her population, takes second place among the countries of the world to the United States, which has 14.2 telephones to every 100 people. Following, come Denmark, 9; New Zealand, 8.7; Sweden, 6.9; and Norway, 6.1. In Great Britain there are only 2.8 telephones to each 100 of the population and in France 1.7.

CANADA'S total recorded production of gold since the year 1858 now amounts to 580,786,381 dollars. The world's total production of gold has been declining since 1912, but the Canadian output is still increasing annually, and since 1922 Canada has stood third among the countries of the world as a producer of this precious metal. The present output is at the rate of nearly 100,000 dollars per day, and this rate will probably, according to the Ministry of Mines, continue to rise for some years.

THE gates to the wet dock at Ayr have not been used for many years, and the London, Midland and Scottish Railway Company has decided to remove them and to take away the sill, which is 3ft. above the bottom of the dock. Work was commenced on June 30th, and, when completed, the depth of the water at the dock entrance will be increased by 3ft., giving 22ft. and 15ft. at high and low water respectively, and thus affording accommodation for larger vessels than hitherto have been able to use the dock.

THE Home Secretary is calling the attention of local authorities to changes in the law under the new Act relating to the storage and conveyance of petroleum spirit, which take effect at once. He points out that a new scale of fees in respect of licences for the storage of petroleum spirit is substituted for the present 5s. fee, and that the occupier of the premises is required to post up the conditions of the licence. A licensee violating these conditions is liable to a penalty of £20 for each day the contravention continues. Moreover, occupiers of licensed premises must give notice to the Home Office of accidents caused by explosion or fire involving petroleum spirit. Instructions for the testing and manufacture of petroleum spirit also form part of the new regulations.

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DEATH.

SATURDAY, July 31st, Mr. EDWIN B. PHILLIPS, chairman and late managing director of Harper, Phillips and Co., Ltd., Albion Foundry, Grimsby.

THE ENGINEER.

AUGUST 13, 1926.

Electricity Supply.

WHILE the address on the "Present and Future Development of Electricity Supply," delivered by Sir John Snell before the Engineering Section of the British Association, contained many familiar arguments which have been used to support the super-power station system of electricity supply that is about to be established in this country, it was not by any means without interest. Although Sir John is, of course, a staunch supporter of the inter-connected super-power station scheme, he does not fail to recognise that cheap electricity supplies involve something more than efficient generation. Far too much emphasis has been laid on the advantages of generating electricity in large power stations, and the benefits which that practice is likely to bestow on the consumer, whilst the capital expenditure on transmission lines and distribution systems and their operating costs have been ignored. As far as we are aware, there is nothing in the new Electricity Bill to make economical distribution compulsory or, in fact, nothing which affects distribution at all; notwithstanding that on Sir John's showing the average cost of low-tension energy, after distribution, is two and a quarter times the average cost of energy that only requires high-pressure transmission lines. There is no doubt whatever that if cheap electricity supplies are to be established in this country, the design of the future distribution systems will require very careful consideration. At the present time the local costs of distribution differ widely, and although Sir John spoke of an average cost of nine-tenths of a penny per unit, it is pretty certain that many consumers will have to pay considerably more than that.

A significant fact mentioned in the course of the address was that the cost of converter sub-stations is some seven to eight times greater than that of static transformer sub-stations. The actual cost, for example, in Glasgow is £15.96 per kilowatt installed for the former and only £1.822 for the latter, the ratio of the costs in this case being 8.76 : 1, whilst if the operating costs, including the capital charges, be compared, the figures are 0.1926d. and 0.0334d. per unit respectively. In a large English city where alternating current distribution has been adopted, except for the supply of the local tramway system, the capital outlay on distribution, including high-tension feeders and sub-stations, low-tension mains, services, and meters, has actually been reduced to £13.48 per 1000 units sold, whilst the future cost is estimated at £11.25 per 1000 units sold. These are facts which those who desire to perpetuate the practice of extending their direct-current distribution systems should bear in mind, and the matter also claims the attention of electric traction engineers. In the traction field, the merits of high-pressure alternating-current distribution for long distances are not as yet recognised, or, at any rate, not in this country. When the practice of working long-distance electric trains with 50-cycle single-phase current was altogether impracticable, there was perhaps some justification for converting the current, but now that this 50-cycle alternating-current system appears to be emerging from the experimental stage, it should at least be carefully considered before embarking upon an extensive system of direct-current electrification. The present tendency to use 50-cycle current for the propulsion of trains is the result of an endeavour to secure the utmost economy and to combine the traction and industrial loads with a minimum amount of complication and loss. For many years past the whole trend of development in direct-current traction has been along the lines of higher working pressures, but really high voltages have not been reached. Whilst the mercury vapour rectifier has removed some of the sub-station difficulties, the problem of applying really high voltages to the train motors remains, and in the opinion of many continental engineers long-distance heavy electric trains should be fed, at any rate, with high-pressure alternating current, which can be produced more cheaply than direct current. There is no question that high-pressure alternating current is going to play a very important part in the electricity supply business of this country. On account of the increasing difficulties of meeting the growing density of loads arising from domestic requirements and the relatively high cost of low-tension distribution, there is already a revival of the so-called "house-to-house" system. Large blocks of buildings are now being supplied by high-tension mains, and transformers installed locally reduce the pressure to a value suitable for use.

Most of Sir John's arguments in favour of large inter-connected generating stations are, as we have already indicated, quite familiar to those associated with electricity supplies, but they are not by any means universally accepted. While, for instance, the practice of inter-connecting power stations is generally considered to be beneficial within limits, the possibility of improving the general load factor throughout the country by linking up all the big centres of supply, is believed by many to be outside the realms of possibility. That the peak load in one district occurs at a time substantially different from that in another district is a matter that has often been questioned, for there is little evidence to show that the habits of the population in different parts of the country vary to any marked extent. Nor is it at all certain that the scheme is going to bring cheap electricity within the reach of all the farmers. As Mr. W. B. Woodhouse has pointed out, an inspection of the map will show that transmission lines between the principal industrial areas will not affect many large agricultural districts, and in any event high-pressure lines cannot be tapped economically to supply small users. The supply of electricity in rural districts is already developing in other ways, and, in the opinion of some engineers, it can be still further extended without the introduction of the Government's scheme. The fulfilment of the scheme will necessarily occupy many years, and it is possible that before it is complete something quite new will be in sight. Great efforts have been made to improve the efficiencies of power stations, but for the most part the workers in this field have adhered to the same fundamental principle, and it is surely time that scientists and engineers alike made a determined effort to discover whether a more direct and efficient method of generating electricity cannot be devised.

The New Filtration Plant at Walton.

WE complete in to-day's issue our description of the new filtration and pumping plant of the Metropolitan Water Board at Walton-on-Thames. Were it only for its size, this installation would command respect, for it will, if called upon to do so, purify and send forward into the delivery mains no less a quantity than 35 million gallons of water per day, and can raise that quantity to a height of 257ft. Now, 35 million gallons are, as

has already been pointed out, sufficient to provide a city of one million inhabitants with 35 gallons per head per day, which is about the quantity delivered on the average to each dweller in the area of Water London. In fact, the new plant at Walton could satisfy the full needs of such a city as, say, Birmingham, or Melbourne, both of which contain about a million persons; yet when compared with the huge volume of water supplied within the Board's area, its total delivery only forms between one-seventh and one-eighth of the whole. Moreover, its capacity is not the only direction in which the plant is interesting; there are certainly two other points which render it noteworthy. In the first place, it is an outstanding example of the use, on such a large scale, of primary and secondary filtration, and, secondly, provision has been made for chlorinating the whole of the water as it comes away from the secondary filters. Primary filtration, followed by treatment in ordinary sand filters, albeit at a rate in excess of that employed when slow sand filters are used alone, would, nearly certainly, produce an effluent of excellent quality, but the Water Board rightly determined to take no risk. It decided to provide for possible treatment by chlorine gas, so as to produce, not only a clarified effluent, but also, should it be found necessary to do so, a positively sterilised filtrate as well. When it is considered that, in the ordinary course, only water, that has been stored in reservoirs for a period long enough to ensure the complete destruction of all pathogenic bacteria, will be fed to the primary filters, and after that treated on secondary filters, it is fairly safe to say that chlorination will not often be required, if it ever is. Still, it should be remembered that there is provision for using unstored water direct from the river, should occasion demand it, and, in that case, chlorination would certainly be beneficial.

The new plant is possibly the best equipped and most up-to-date waterworks installation at present in existence. Every detail appears thought out most thoroughly, and every contingency anticipated. The paramount essential of water supply arrangements and machinery is that everything should be capable of operating without breakdown. Everything at Walton bears the stamp of good workmanship. We saw nothing which did not appear to be thoroughly substantial and capable of performing any duty which it might be called upon to perform. Moreover, very considerable skill has been brought to bear in blending the extension to the engine-house with the original building. No one, not aware of the fact, would, we think, imagine for a moment that the whole pumping station had not been built at the same time. The new pumping machinery, it is true, is very different from the old; but, then, the work it has to do is very different. Excellent as is the new machinery, however, it does not depart in any marked degree from existing machinery of the same class, and the particular feature which differentiates the installation as a whole from other similar waterworks is that primary followed by secondary filtration has been adopted on a large scale. There is no need for us to discuss here at any length the advantages of combining primary and secondary filtration. Only one aspect of the matter need be considered in the present instance. It is that it is thought probable that at Walton it will be possible to work the secondary filters at from three to four times the normal rate for slow sand filtration, and yet be certain of an equally good result. That means that whereas to treat a given quantity of water, an area of from $3\frac{1}{2}$ to 4 acres is necessary when using slow sand filters alone, the same quantity of water can be as effectively dealt with by 1 acre of beds, providing the water be previously passed through primary filters. The additional area of land required for accommodating the primary filters is, at Walton, about $\frac{4}{5}$ of an acre, or, as there are 5 acres of ordinary beds there, at the rate of $\frac{1}{5}$ of an acre of space for primary filters for every acre of secondary filters. This ability to save space will, no doubt, prove of very considerable importance in cases in which either land sufficiently level for the construction of slow filters at a reasonable cost is not available, or in which the price of land is so high as to be prohibitive.

The working of the new plant will be followed with considerable interest, for there are numbers of points on which it should throw a great deal of light. For instance, it appears to be quite within the bounds of possibility that it may be found that it is feasible always to apply raw river water to the primary filters, and yet to obtain first-class effluents from the secondary filters. In any case, the Board's engineers would feel quite happy in trying such an experiment, since there is always chlorination to fall back upon. If it were found practicable and desirable to follow that course, it might possibly affect the Board's policy with regard to storage reservoir construction. Less power would also be required to pump the water to the filters than into reservoirs. Naturally, the use of raw river water instead of stored water would mean that the primary filters would get choked up more quickly, and would therefore require to be cleansed more frequently. That would entail additional cost, and the problem would be to ascertain by which method of procedure the greater volume is passed through for a given expenditure, naturally with the same quality of effluent in both cases. Then, again, there will be an excellent opportunity of ascertaining whether, with suitable land available at a given cost, it is financially more economical to treat the water wholly in sand filters, or by primary and secondary filtration. Furthermore, it may be found possible, with chlorination as a safeguard, to work the secondary filters at an even higher rate than that at present proposed. If that were possible, then an even smaller unit area than that at Walton would suffice for the filtration of a given volume of water. Nor do the foregoing exhaust the list of subjects for possible investigation. There has, as we intimated in our articles, still to be determined which type of engine it will be best to install, taking everything into consideration, when the time comes to make an addition to the pumping plant. Altogether, we can foresee in front of the Board's engineers a series of investigations which are certain to produce some most instructive results.

Obituary.

THOMAS JAMES MOSS-FLOWER.

We have received for publication the following particulars of the career of the late Major T. J. Moss-Flower, whose death took place on July 19th:—

Thomas James Moss-Flower was born in 1864. He set up in private practice as a civil and consulting engineer in Bristol in 1887. From 1891 to 1899 he was Engineer and Surveyor to the Portishead Urban District Council, and during that time, in addition to many other public works, carried out an entirely new sewerage scheme for the whole of the district of Portishead, including about 9 miles of sewers, a long sea outfall, engines, pumps, and other incidental works. He also acted for some considerable time as engineer to the Portishead District Water Company.

On leaving the service of the Portishead Council Mr. Moss-Flower continued, except for the period of the Great War, when he was on active service, his private practice as a civil and consulting engineer in Bristol and London, till the day of his death. During that time he carried out work in connection with the erection, alteration and addition to many buildings, both public and private, and numerous civil engineering works of a varied nature in different parts of the country. From 1900 onwards he was largely engaged in the carrying out of public works for various corporations, and consisting chiefly of drainage and water supply schemes. During this period he carried out, amongst other works, Hullavington water supply; Allington water supply; the main drainage of Portishead, Somerset; the main drainage of Hartley Wintney, Hants; of Rye Harbour, Sussex; of Tenby, Pembrokeshire; of Fleet, Hants; of Wootton Bassett, Wilts.; of Pencoed and Coychurch Higher, Glamorgan; of Havant, Hants; and Victoria, Brazil.

The late Major Moss-Flower took a very keen and enthusiastic interest in the work of various engineering associations. He was an associate member of the Institution of Civil Engineers, a member of the Institution of Municipal and County Engineers, a fellow of the Royal Sanitary Institute, a past-president of the Institution of Sanitary Engineers, a fellow and member of the Council, and of the Board of Examiners of the Institution of Sanitary Engineers, a past-president of the Bristol Association of Engineers, &c. &c.

Apart from his professional work, Mr. Moss-Flower took a wide interest in various other activities and served for some years in the Volunteer and Territorial Forces, attaining the rank of Major. At the outbreak of the Great War he offered his services to the War Office and served first with the Rifle Brigade in Egypt, and then in France, where he was engaged with the Royal Engineers, until the cessation of hostilities, supervising the carrying out of large constructional works in connection with military operations.

Production in Canada of radio apparatus, including sets, parts, and batteries, reached a total value of 5,548,659 dollars in 1925, according to the Dominion Bureau of Statistics. Six plants in Canada were engaged solely in the manufacture of radio sets or parts. Imports of radio apparatus totalled 3,552,537 dollars during the period. Radio licences were issued to 134,486 persons.

Literature.

Steam Turbines. By Guiseppe Belluzzo. Translated by Engineer-Captain A. G. Bremner, R.N. London: Charles Griffin and Co., Ltd. 1926. Price 42s. net.

Every translator of a technical work is to be commended for rendering the literature of one country available to the readers of another, as even though progress is not necessarily advanced thereby, designers still have the satisfaction of knowing in what manner technical information is presented to men of the same calling in other lands. Captain Bremner has chosen an imposing volume for rendering into English and has done full justice to his abilities as a translator. The author of the work in question, Professor Belluzzo, is perhaps best known to English engineers as the designer of a steam turbine of which the direction of rotation could be changed by passing the steam through blade passages of reversed curvature. A turbine of this type was tried on a locomotive in 1906 and in an Italian torpedo boat in 1913, but the system has never made headway. Professor Belluzzo is evidently a man of considerable energy and of varied parts, for at the present time, in addition to occupying the Chair of Heat and Hydraulic Engineering at Milan Polytechnic and acting as President of the National Association of Italian Engineers, he finds time to serve simultaneously as Minister of National Economy in the Mussolini Cabinet. There is no record in the translation of his book of the date at which it was first published in Italian, but as it contains references to articles which appeared in the English technical Press less than four years ago, the time of its publication is approximately fixed. It must therefore be judged as a modern book, and from that point of view it certainly cannot be held to rank superior to treatises already existing in the English language. It has the misfortune, as the translator realises, of entering a field previously well occupied, but as representing the work of a well-known continental expert, and reflecting, presumably, the state of the art as practised by Italian designers, it is bound to interest English turbine engineers.

The book, a handsome and fully illustrated volume of about 730 pages, commences somewhat disappointingly. Its opening chapter dealing with the properties of steam is, according to English ideas, thoroughly out of date. The work of Callendar is completely ignored, and we find instead such information as the following:—"The relation between λ [total heat] and t is also known, having been deduced by Zeuner on the basis of Regnault's tables, and is given by $\lambda = 606{\cdot}5 + 0{\cdot}305\,t$. Less known perhaps is the most recent relationship deduced from the experiments of Professor F. Henning, viz., $\lambda = 606 + 0{\cdot}311\,t$ for values of t less than 180 deg. Cent." Now a few pages before these statements appear there is a table giving the principal properties of saturated steam, "according to the latest investigations." Taking at random steam at a temperature of 35·8 deg. Cent., the table gives the total heat as 611·9 calories per kilogramme. Calculating the total heat from the two formulæ given, we get 617·4 calories and 619·1 calories respectively. It is unfair to the student to confront him with discrepancies of this nature without comment. Henning's "most recent relationship" certainly gives a result further from the truth than either of the others, and it is probable that even the lower of these is too high. As Callendar's work was available before the book was published, there is no excuse for dependence on the contradictory results of earlier physicists.

In all the matter devoted to the flow of steam through nozzles, blades, &c., there does not seem to be much with which the English engineer is not already acquainted. The experiments of Rateau, Briling, Christlein, Rosenhain, Stodola, and Banki are all referred to at greater or less length, but without much attempt at co-ordination. A few paragraphs are devoted to the question of supersaturation. Professor Belluzzo appears to accept the existence of this phenomenon, but his explanation of it is hazy to a degree. After saying that "condensation of steam is always accompanied by the existence of electrons in the mass of the steam," he adds, "if these do not exist or do not have time to be formed during the expansion we have the phenomenon of the lowering of pressure without that of temperature." This is wrong. If, owing to the absence of electrons or dust particles condensation is retarded, the consequence is to produce an unduly low temperature, because the latent heat which would be set free by condensation is not given up. The author goes on to say, "since it is possible in practice to create electrons in the steam which flows from a nozzle by the methods taught us in physics, so some experimenters . . . have succeeded in obtaining by expansion through a nozzle wet steam at temperatures less than those corresponding to the pressures given in the tables." This statement, besides being such a terrible *non sequitur*, is extremely misleading. Supposing that the steam tables correctly represent the conditions of thermal equilibrium, and that some experimenters have found temperatures less than those corresponding to the pressures, they have observed the phenomenon of supersaturation, which is due to the absence of those electrons which it is

implied that the experimenters have furnished. It may certainly be possible to "create electrons in the steam . . . by the methods taught us in physics," but it is highly probable that it is impossible to create enough to affect the condensation of steam flowing through a nozzle, and we may mention that elaborate and costly unpublished experiments in this country have failed to show any effect whatever from the addition of electrons by various methods.

Coming to the sections of the book dealing with mechanical details, nozzles, blading, glands, bearings, &c., are illustrated and described with sufficient completeness to give the student a very fair idea of modern practice. The design of rotors, drums, and shafts is also dealt with at some length, the methods of calculation for strength, critical velocity, &c., being also explained. An obvious misprint occurs on page 331, where the value of Poisson's ratio is given as 10·3 for steel. In all new technical books one naturally looks for the treatment of subjects of current interest to designers, and in the present case one is disappointed to find no reference to the phenomenon of axial vibration of the wheels of impulse machines. It has been known for some years that these wheels, when thin, are liable to get into a state of axial vibration if their running speed corresponds to the natural period of such vibrations. It is probable that the bursting of some of these wheels is due to this cause, rather than to the poor quality of material or non-homogeniety of its structure, which are stated, somewhat pontifically by the author, as being the only causes of such accidents. The book might well have dealt with the question of axial vibration of discs, and a description of the experimental methods of determining the natural periods of this vibration might also have found a place.

Among the turbines selected for illustration there does not seem to be a single example of a two or three-cylinder machine. Referring to such machines, the author says on page 280 that "separate high and low-pressure cylinders are still adopted by Parsons and by some firms using his patents, for turbines of over 15,000 horse-power." This is, of course, correct, so that it is somewhat of a shock to be told on page 581 that Parsons has "recently substituted the construction in one casing" for "construction in two cylinders . . . . which proved cumbersome and costly." As everybody knows, the two-cylinder construction has not been abandoned at all, but is becoming more and more favoured for large machines. Several examples of the author's forgetfulness of what he has said before could be given, but we need only refer to the Baumann divided exhaust, which is attributed to "some American firms" on page 200, and correctly to the Metropolitan-Vickers Company on page 595. Professor Belluzzo does not seem to like the Ljungström turbines, which he calls "complicated and delicate," and says that "owing to their high cost and owing to difficulties experienced in running, they are not frequently met with." The only explanation of such an indictment is that he does not know much about them, for his book in general is scrupulously fair and free from bias. About ninety pages are devoted to marine turbines, geared and otherwise, and about a dozen to turbine locomotives. As regards the latter, one might have expected more, owing to the author's own efforts to apply a turbine to a locomotive. He illustrates the machine in question, which was a small shunting locomotive, with two independent axles, each of which was driven by two turbines with single reduction gear. All four turbines were of the single-stage velocity compounded type, with double curvature blades for reversing, and the four turbines worked in series. A short description of the Ljungström turbine locomotive, which is the most successful yet constructed, and indeed the only one in regular main line service, is given also.

One cannot help being struck, when reading the book, by the extent to which the author has relied on English sources of information. The technical Press and the "Proceedings" of the Institutions of this country are laid under almost incessant contribution. For Italian readers nothing perhaps could be better, but the fact results in a great deal of the information in the book being already familiar to English designers. One does not get the impression that Italian turbine engineering is in any way ahead of British, either in theory or practice. Furthermore, as regards the latest features in turbine practice, such as steam reheating, progressive feed heating, and the construction of large multi-cylinder machines, the book has little or nothing to say. It does, however, contain a vast amount of interesting material, and it possesses the extra attraction of showing turbine design as the Italians are taught to see it.

Science and the Modern World. Lowell Lectures, 1925. By Alfred North Whitehead. Cambridge University Press. 1926. Price 12s. 6d.

This is a remarkable book, but not a book for everyone. A great deal of it is pure metaphysics, and that evasive science is wind in the eaves to those who have no sympathy with it. But just as there are people outside the circle who do want to know what Epstein and Cezanne mean, or to apprehend the inwardness of the music which they are told exists in symphonic-syncopation, so there are others who with puzzled brow try to see over the shoulders of philosophers what it is in metaphysics that sets wise men staring. We are not sure that this is the best book they could go to for a beginning, particularly if they are already scientists in another sphere. They would do better, perhaps, to start with Karl Pearson, who never quite lets go of the rope that attaches him and the inexpert swimmer to solid earth. Yet there is this in Professor Whitehead's work which raises it above the arid logic of the metaphysical whole-hogger. The reader feels, particularly in the earlier and later lectures, that all the time he is striving to reach out to "a power outside ourselves that makes for righteousness." Not only scientific righteousness, but moral righteousness. He is questing throughout, quartering the field of human knowledge, to find somewhere something upon which the mind of man may take hold and thereby elevate itself. It is a commonly accepted belief that the magnificent architecture of the Gothic period sprung from the loins of simple religious faith; there can be no question, too, that literature and painting up to the end of the seventeenth century owe their power to an unwavering adherence to elemental beliefs. It matters little that some of those beliefs had no sure foundation, and that they tumbled down before the assaults of inquisitorial and experimental science. Yet, errors though they were, they served a fine purpose and provided men with ideals. Goodness in those days was goodness, virtue was virtue, wickedness was wickedness. Cynics had not yet arisen to proclaim goodness no more than a desire to feel self-satisfied with oneself, and wickedness was not yet merely the outward effect of faulty metabolism or defective chemical reactions in the brain.

In the nineteenth century faith in God and faith in ghosts departed together. Step by step with material progress, step by step with the advance of science, the simple beliefs of our forefathers were trampled under foot. Geology destroyed Genesis. Science killed superstitions, and even the most religious people had either to consent to a painful modification of their views or bind their eyes and wax their ears. Parallel with the Victorian priggishness of "Art for Art's sake," there grew up an equal scientific priggishness, "Truth for Truth's sake." Only the greatest scientists admitted that they were yet as children playing with pebbles on an endless shore. The mass of the "intellectuals" believed that they had found the Truth, the whole Truth and nothing but the Truth. Even the wisest could only suspend judgment and say, with Spencer, they did not know.

It is hardly to be doubted that this entire lack of faith in everything but experimental knowledge has had an injurious effect upon the ethical and æsthetical world. With nothing firm to which he could hold, no faith which might not be shattered at the next meeting of the British Association, no belief which might not be dissolved on the lecture table of the Royal Institution, man found himself perpetually presented with Truth and perpetually discovering faults in it. With the mind in a state of continual flux, high aspirations cannot flourish. "Paradise Lost" would never have been written had German exegesis existed in Milton's day; one cannot build greatly on a bank of moving clay. Science in its magnificent and irresistible stride trampled upon what men had held dear and incorruptible, whilst the astonishing advance of industry left the world little time to think of what it had lost or was losing.

All this was inevitable. It is neither to be condemned nor praised. It was the natural result of a sudden access of knowledge. But the pendulum is showing faint signs of returning upon its path. There is a growing feeling, not least amongst scientists, that something more is required for the completion of man's happiness than an obvious material world. Men here and there, Professor Whitehead amongst them, are beginning to wonder if there is not, indeed, some deeper truth than any we have yet fathomed. Some truth, perchance, that will lift us out of the laboratory, that will give us a glimpse of a power outside ourselves that makes for all kinds of righteousness, and possibly restore, possibly take the place of, that ancestral faith which was haled, chained and naked, behind the triumphal car of Science.

That, we take it, is the theme of Professor Whitehead's Lowell Lectures, which are here collected. He is clearly an admirer and believer in pure reason. "The paradox," he exclaims, "is now fully established that the utmost abstractions are the true weapons with which to control our thought of concrete fact." Induction to his mind is second-rate stuff, "the despair of philosophy." Necessary, of course—as the palette and canvas are, but, like them, incapable alone of producing a work that may inspire great emotions. Moreover, inductive science is for ever changing. The truths of to-day are not the truths, or at best only a poor part of the truths, of to-morrow.

Professor Whitehead startles us in one of his earliest lectures by asserting, of the Middle Ages, that "it was pre-eminently an epoch of orderly thought, rationalist through and through." It held the "inexpugnable belief that every detailed occurrence can be correlated with its antecedents in a perfectly definite manner," that "the avenue to truth was predominantly through a metaphysical analysis of the nature of things, which would thereby determine how things acted and functioned." It does not matter at all, we take it, that many of the arguments were based on unsubstantiated "facts." Were we to despise them on that account, Heaven knows how our pride might recoil upon ourselves when future generations find that the nineteenth and twentieth century were as full of error in their degree as the sixteenth and seventeenth.

In his third lecture, our author brings us face to face with our own limitations. "You will observe," he says, "that I do not hold Induction to be in its essence the derivation of general laws. It is the divination of some characteristics of a particular future from the unknown characteristics of a particular past." That, of course, is a familiar argument against induction. Our physical laws are no more than formulæ expressing our belief that in the domain of physics history repeats itself for ever and ever. We believe that the sun will rise to-morrow because it rose yesterday, and to the best of our knowledge for millions of years before that. But in that belief we are guided only by experience, not by reason. Whether we shall ever get beyond that stage, whether we shall ever be able to see the "necessity" of the laws of nature, none can say. The tendency at the moment is to regard them as no more than the result of probabilities. The combination of two volumes of hydrogen with one volume of oxygen to form water is the result of a calculable probability that the elements will combine in that proportion. These are but dim visions of some all-embracing "law." Professor Whitehead doubts that we shall ever pierce the cloud. "Let us grant," he says in the peroration of his fourth lecture, "let us grant that we cannot hope to be able to discern the laws of nature to be necessary. But we can hope to see that it is necessary that there should be an order of nature," and in the next lecture he asks, "Is it not possible that the standardised concepts of science are only valid within narrow limitations, perhaps too narrow for science itself?" and a little later, "Of course, with the exception of those who are content with themselves as forming the entire universe, solitary amid nothing, everyone wants to struggle back to some sort of objectivist position." Man must be for ever seeking some further truth that will bind together into a single whole all the little truths he has hammered out from facts. He cannot hang for ever betwixt heaven and earth. "Now by aspirations lifted, by misgivings downward driven." He seeks something solid upon which to set his foot; at each stage of the ascent he tries every stone before putting his weight upon it. He climbs by induction, but Professor Whitehead will have it that in the end when he nears the summit nothing but pure reason can avail him. And that there is a summit he is convinced. But we will not venture to follow him in his chapters entitled "God" and "Religion and Science." They must be read by those themselves who desire to see how such subjects may be handled metaphysically. He recognises the conflict between science and religion, but believes that in time unity may be found. "We should wait," he says, "but we should wait not passively or in despair. The clash is a sign that there are wider truths and finer perspectives within which a reconciliation of a deeper religion and a more subtle science will be found."

Our attempt in this review has been rather to show the object at which Professor Whitehead aims than to discuss the means by which he endeavours to prove the existence of that object. We do not, indeed, feel ourselves fitted to wrestle with the intricacies of his metaphysics, and we shall be surprised if more than a very few were able to follow them in spoken lectures. In many places we floundered vainly after his arguments, and were relieved when he got back to touchable facts and ordinary human aspirations. It is such things, rather than the skilful manipulation of metaphysical jargon which raises the volume out of the ordinary. Indeed, lest anyone should fear to read a book which is well worth reading, let us say that the metaphysical parts may be skipped without serious loss. The remainder, a large remainder, which deals with human things, which inspires the hope that somehow, some day, men may again find a faith, we know not of what kind, but a faith that will disperse mere materialism and restore some of the emotions which inspired the greatest labours of the past, that it is which must give to Professor Whitehead's Lowell Lectures a value to all who see visions and dream dreams.

BOOKS RECEIVED.

Loughborough College Calendar for 1926–27 Session. Loughborough: The Echo Press.

Electrical Characteristics of Transmission Circuits. Compiled by W. Nesbit. East Pittsburg: Westinghouse Technical Night School Press, Pa., U.S.A.

The World Race for Trade. Reprinted from the *Daily Chronicle.* London: The United Newspapers (1918), Ltd., 3, Salisbury-square, E.C. 4. Price 6d. net.

Bulletin of the British Cast Iron Research Association. No. 13. July, 1926. Published at the offices of the Association, Central House, 75, New-street, Birmingham.

Empire Forestry Journal. Vol. 5. No. 1. 1926. Edited by Fraser Story. Published by the Empire Forestry Association, 22, Grosvenor-gardens, London, S.W. 1. Price to non-members, 4s. net.

"Transactions" of the Optical Society. Vol. XXVII. 1925–26. No. 4. Published by the Society at the Imperial College of Science and Technology, South Kensington, London, S.W. 7. Price to non-members, 10s.

London Electric Railways: Extensions.

No. II.*

THE MORDEN EXTENSION OF THE CITY AND SOUTH LONDON RAILWAY.

In the session of 1923 the City and South London Railway Company sought for powers to extend its line from its terminus at Clapham Common to a junction with the authorised—but not constructed—Wimbledon and Sutton Railway. As the latter line was an important factor in the scheme, it should be said that powers for its construction were obtained by private promoters in 1910. It was to start at Wimbledon in continuation of the bay lines on the north side of the London and South-Western station used by the Metropolitan District trains, and was to terminate at Sutton by a station alongside that of the London, Brighton and South Coast Company. Junctions with the London and South-Western were arranged, the Metropolitan District was to work the line, and the only opposition came from the London, Brighton and South Coast Company. The proposals for the Wimbledon and Sutton Railway were, however, approved, but nothing further had been done in the matter when the Morden Extension came before Parliament in 1923.

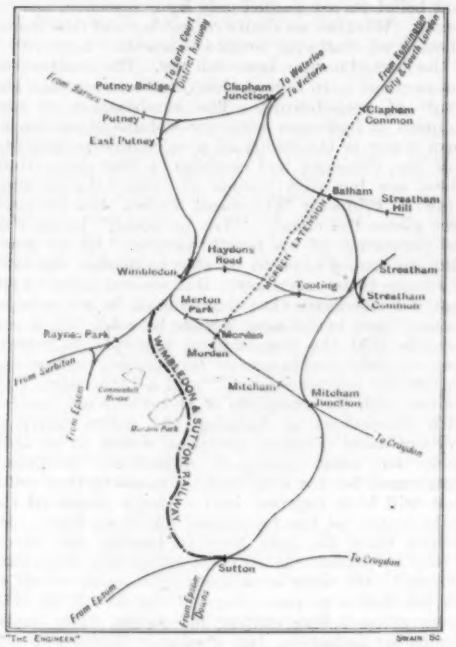


FIG. 12—PLAN SHOWING ROUTE OF MORDEN EXTENSION

When the City and South London Bill was before a Committee of the House of Commons in April, 1923, the Southern Railway opposed it, in order to raise the question as to a limitation to the activities of tube railways. It made no objection to an extension as far as Tooting, and was willing to relieve the District Railway of all responsibility for the Wimbledon and Sutton line. Eventually an agreement was arrived at between the two interests. The City and South London was to be extended to Morden, but not as far as was intended, and the Southern was to acquire the Wimbledon and Sutton. The Bill as amended, therefore, passed, and the following year—1924—the transfer of the Sutton line was also sanctioned. The course of the new line is shown in Fig. 12. It follows the route of Balham-road, Merton-road and of High-street, Merton, and the stations are at Nightingale-lane—to be known as Clapham North—Balham, Tooting Bec—to be known as Trinity-road—Tooting Broadway, Colliers Wood, South Wimbledon and Morden. The present station at Clapham-road is to be called Clapham North.

The Morden Extension commences at the buffer stops at the west end of Clapham Common Station and ends at Morden, a distance of 5 miles 15 chains. Except the car sheds and carriage sidings at Morden, which have been executed by the railway company's own forces under Mr. Arthur R. Cooper, the company's engineer, the plans for the work were prepared by, and the work carried out under the supervision of, Messrs. Mott, Hay and Anderson, the consulting engineers, who were responsible for the construction of the original City and South London Railway, when opened in 1890, and for its subsequent extensions and the enlargement of the original tunnels to the standard dimensions in 1922–24.

The construction of the present extension has been the subject of several contracts. As a preliminary, the sinking of the temporary working shafts and excavation of the service headings and the 15ft. chambers for the erection of the excavator shields were entrusted to Walter Scott and Middleton, Ltd. As a consequence, when the contract for the running tunnels was let everything was in readiness for the contractor to install his pit-head gear and surface plant, and to erect the excavator shields in the chambers prepared beforehand.

The main tunnel contracts—including also the escalator tunnels—for the section from the existing terminus at Clapham Common to the north, or City, end of Tooting Broadway Station was let to Charles Brand and Son, and for the work southwards thence to Morden, including the escalator tunnels, to The Foundation Company. The contract for the construction and erection of the escalators was let to the Waygood-Otis Company.

The City and South London Railway at present terminates, as said above, at Clapham Common, and the two tunnels at that station are continued for about 1000ft. as train-reversing and carriage storage sidings. The buffer stops are to be removed from these sidings, which will no longer be used as such; but will form the commencement of the new railway which will pass through extensions of the present tunnels. The excavations for the latter were undertaken from two shafts near Nightingale-lane, and the southbound and northbound tunnels were driven simultaneously under free air. The 25ft. shield chambers for the 21ft. 2¼in. internal diameter station tunnels at Nightingale-lane were excavated by the contractors for the line, and after the northbound tunnel was built the shield was taken down and re-erected in the southbound shield chamber, so that the southbound station tunnel might be built.

Just south of Nightingale-lane Station two shafts were sunk and two 15ft. shield chambers provided, whence the two tunnels were driven in free air up to the north end of Balham Station. South of Balham Station were sunk another three shafts, which provided for the two tunnels up to the south end of each station, for the station tunnels and for both tunnels southwards to Trinity-road—all done in free air. From three further shafts at Trinity-road the work was carried as far as the north end of Tooting Broadway Station.

For the first 100 yards on both roads southwards from these shafts the work was done in free air and in London blue clay. Wet beds of shelly concretions were then met with, and, as the gradient of the line fell, the shield got deeper into the Woolwich and Reading beds of mottled clay, with veins or pockets of loamy sand. It was consequently necessary for the remainder of the section up to Tooting Broadway Station to be driven under compressed air at from 10 lb. to 18 lb. per square inch.

The formation which had been met with when approaching Tooting Broadway Station, and which was to be encountered in the construction of the two station tunnels there, and for some distance towards Colliers Wood, is a portion of the Woolwich beds, but at a higher level than usual in that part of London. The chief characteristic of this formation is a layer of shell embedded in a shaly clay matrix, which in some cases is almost as hard to get through as concrete. Below it there is a bed of water-bearing sand, varying from a few inches to two or three feet in thickness, followed by another band of hard shell, and, again, by more wet sand. The last-named was found to be 20ft. deep in places, and at the bottom mottled red clay was met with. Beds of clay and sandy clay were also found in the strata.

It was necessary to complete the sinking of the shafts and a short length of both up and down-running tunnels, together with access passages

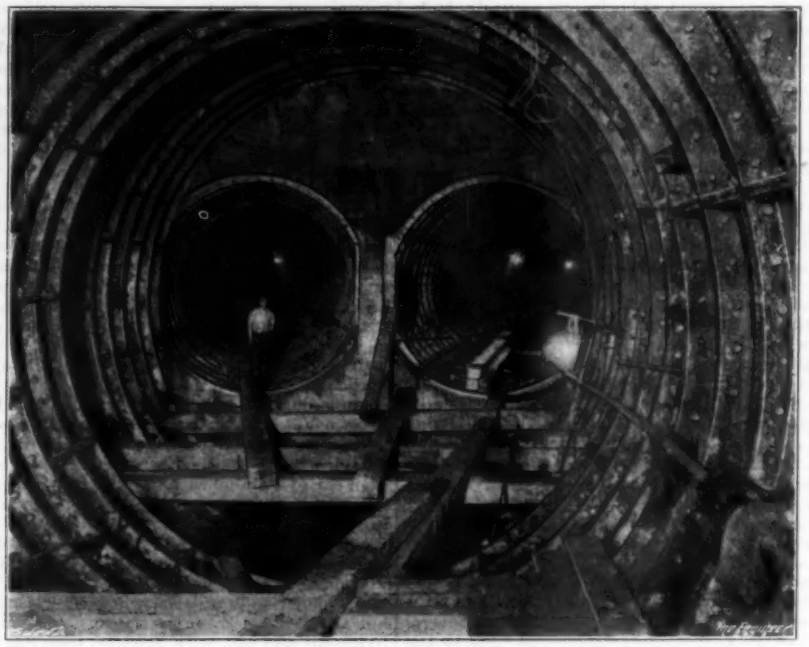


FIG. 14—STEP-PLATE JUNCTION AT TOOTING BROADWAY

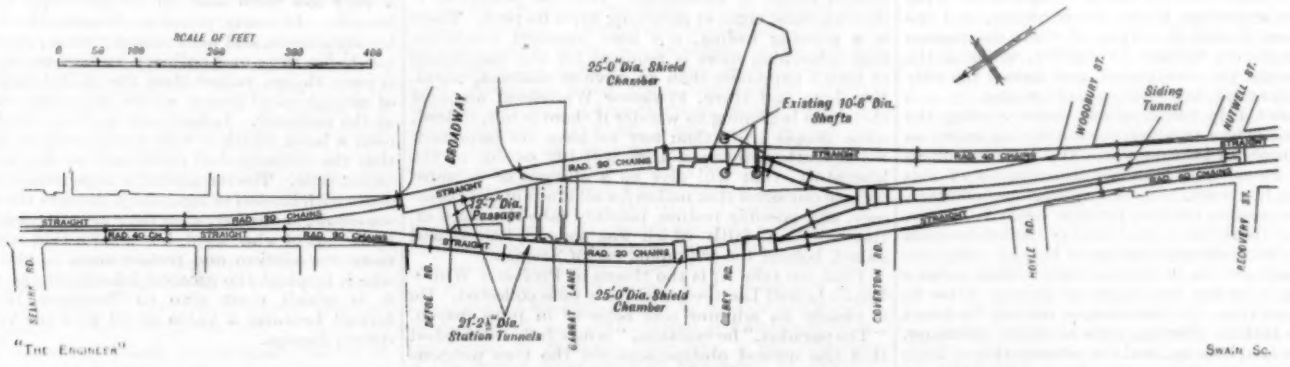


FIG. 13—PLAN SHOWING WORKS AT TOOTING BROADWAY

* No. I. appeared July 23rd.

thereto, through vertical air locks fixed to steel decks in the shafts. On completion of that work the tunnel faces were boxed up, horizontal locks were placed in the tunnels and cross passages, and the vertical locks and steel decks were removed from the shafts. Work upon the whole of the station tunnels, cross passages, step-plate junctions, siding tunnel, and running tunnels for 360 yards towards Colliers Wood was then proceeded with and carried out under compressed air, the pressure required being 15 lb. to 18 lb. per square inch.

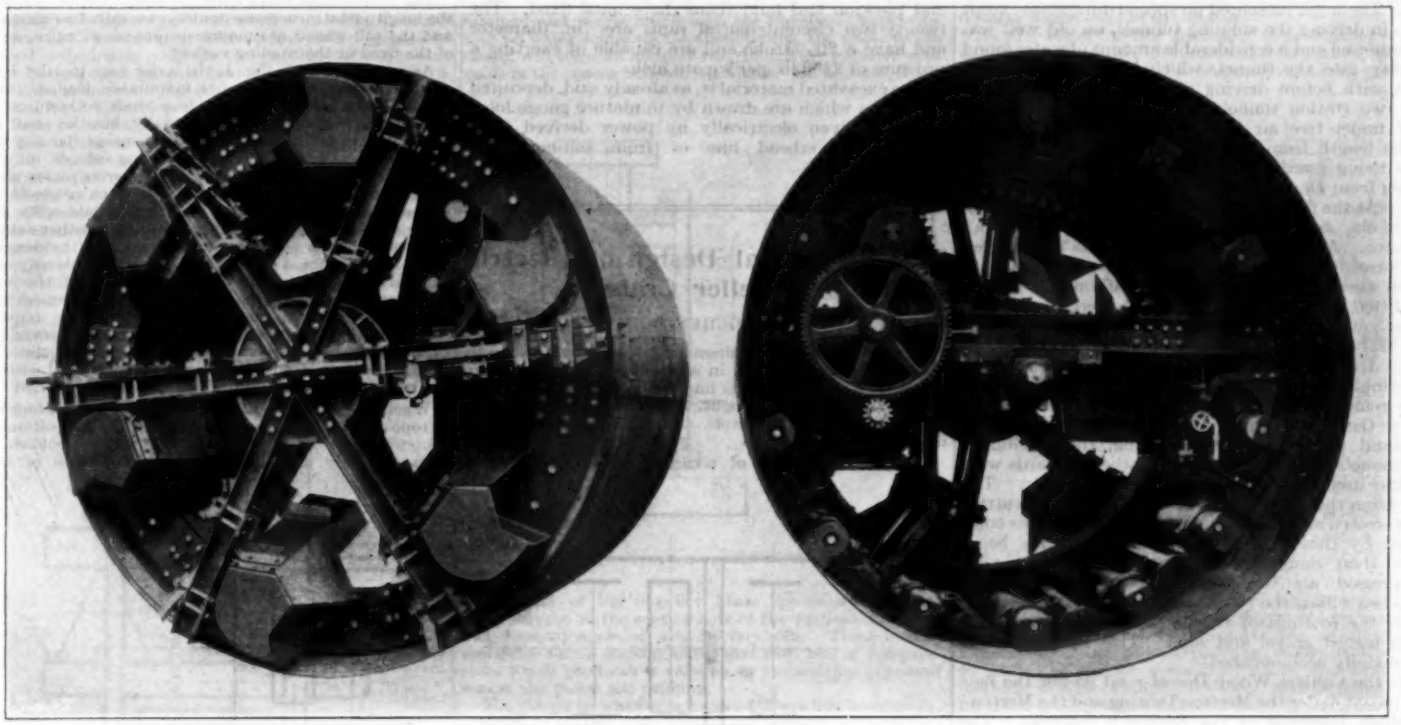
At Tooting Broadway a siding has been provided in between the two running lines. It has a tunnel of the ordinary dimensions to itself. As there is a facing connection in the southbound line and a trailing connection in the northbound line, and the two connections have to join each other at the siding, the tunnel dimensions at those three points have had, to accommodate the additional rails, gradually to be increased from the original internal diameter of 11ft. 8¼in. to 12ft. 6in., 13ft., 15ft., 18ft., 21ft. 2½in., and 25ft. diameter. From one tunnel of 25ft. diameter the two diverging roads lead into two single 11ft. 8¼in. tunnels. The larger diameter tunnels are known as step-plate junctions.

Fig. 13 is a plan of the work as done at Tooting Broadway. The first work was the construction of the 25ft. shield chamber on the southbound line, the 12ft. 6in., 13ft., 15ft., 18ft., 21ft. 2½in., and 25ft. step-plate junctions for the facing siding connection in the southbound line, and the length of 12ft. 6in. for the piece of straight line in the siding connection. From the 25ft. shield chamber in the northbound line the 12ft. 6in., 13ft., and 15ft. step-plate junctions for the trailing siding connections were erected. All this work was hand driven. The southbound station tunnel was then excavated by the shield erected at the south end, and before the completion of this work the piercing of the northbound tunnel was begun with a shield released from Colliers Wood Station. The 18ft., 21ft. 2½in., and 25ft. sections of the trailing siding connection were erected simultaneously with the driving of the southbound station tunnel, and the length of 12ft. 6in. up to the siding step-plate junction was taken in hand. The latter was completed and the siding tunnel—of ordinary dimensions and 386ft. long—was built simultaneously with the driving of the northbound tunnel. Fig. 14 is a view of the step-plate junction as seen from inside the siding. The tunnel on the left takes the left leg leading to the northbound line and the other tunnel takes the other leg leading to the southbound.

It has been mentioned that compressed air working was found necessary on the Trinity-road–Tooting Broadway section. In order to separate that section from those under free air a few rings of 11ft. 8¼in. tunnel were erected in each tunnel on the Trinity-road side and a bulkhead wall, 3ft. 4in. thick, of solid concrete, was built in each of them. Then, as will be related directly, as the tunnels approaching Tooting Broadway from the south were being built under compressed air a similar bulkhead wall was erected on the southbound line south of the station. No such work was necessary on the northbound line, as the air pressure in both sections was the same.

In order to expedite the driving of the tunnels between Tooting Broadway and Colliers Wood two shafts were sunk in addition to those originally intended, at Trevelyan-road, about 1300ft. south of the shafts at Tooting Broadway. From these shafts the work towards Colliers Wood and for about 179ft. on the northbound towards Tooting and 214ft. on the southbound was carried out in free air; the remainder of the work towards Tooting was in compressed air, as already stated. The free air work was in London clay.

When driving towards Colliers Wood the clay first encountered was thought not to be sufficiently good to allow the use of rotary cutters and the ground was excavated with rotary cutter shields used as Greathead shields until about 450ft. from Trevelyan-road



FIGS. 15 AND 16—FRONT AND REAR VIEWS OF ROTARY EXCAVATOR

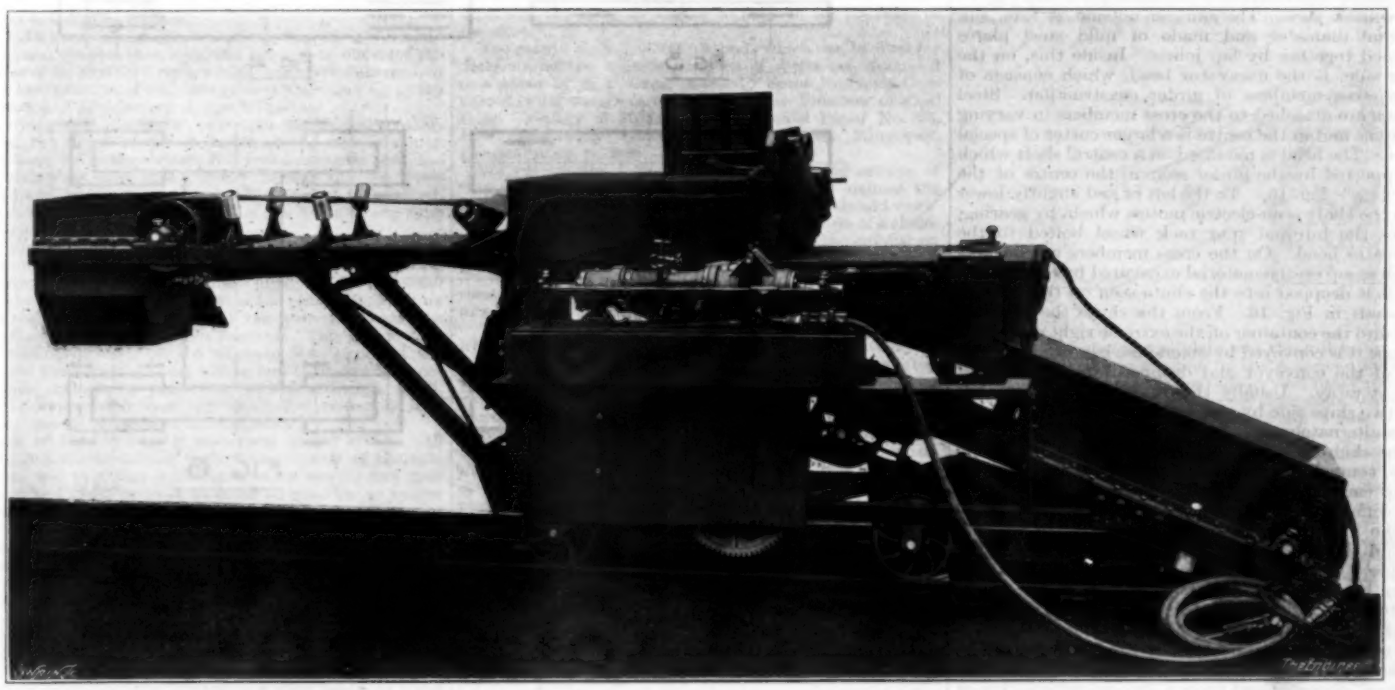


FIG. 17—CARRIAGE FOR EXCAVATED-MATERIAL BELT CONVEYOR, AND HYDRAULIC PRESSURE PUMP

on the northbound and 800ft. on the southbound, when the nature of the clay became sufficiently improved to enable the cutters to be employed.

At Colliers Wood three shafts had been sunk by Walter Scott and Middleton and two 15ft. shield chambers made for the shields for driving the tunnels towards South Wimbledon, besides three connecting headings and two short lengths of ordinary tunnel. The Foundation Company completed the two station tunnels and drove the ordinary tunnels up to the north end of South Wimbledon under free air in London blue clay. The work presented no special difficulties except that, in driving the running tunnels, an old well was encountered and a considerable amount of water found its way into the tunnel, which had to be specially dealt with before driving could be proceeded with. The two station tunnels at South Wimbledon were built under free air from one shaft at that point.

The length from Colliers Wood to Dorset-road is on a rising gradient of 1 in 60. The tunnels were driven from Dorset-road, down hill to South Wimbledon. At the former place the bottom half of the work was in clay and the upper half in sand and gravel, full of water. A short length of open cut was constructed in Dorset-road and shield chambers were built, in which were erected cutter shields without the cutters and fitted with a hood. The tunnels were then driven under compressed air for 922ft. in the southbound and 932ft. in the northbound direction, at the end of which distance the tunnels had dipped sufficiently to be completely in the London clay. The hood was then removed and the ordinary cutting edge fixed and as the clay was not sufficiently strong for the face to stand up to without timbering, the driving of the tunnels was continued for another 60 yards with shields used as ordinary Greathead shields. The formation then reached being much stiffer, the cutters were erected and the remainder of the tunnel was completed by that method, the rate of progress being more than doubled. In the length driven under compressed air the tunnels passed under semi-detached villas, the top of the tunnel being only 7ft. under the footings of the houses. The ground was water-logged gravel and sand. That operation was successfully accomplished.

On the Colliers Wood–Dorset-road length the new line passes under the Merton–Tooting and the Merton–Mitcham branches of the Southern Railway. The former is the first to be met with when coming from Clapham Common, and the segments there were strengthened for 30ft. on each side of the crossing. For the second crossing the segments were strengthened from a point 30ft. on the north side of the crossing to the end of the tunnels at Dorset-road.

The Shields and Excavators.

Quite a considerable amount of the excavating by shield has been done by rotary excavators supplied by Markham and Co. (1925), Ltd., of Broad Oaks Ironworks, Chesterfield, to whom we are indebted for the photographs from which Figs. 15, 16, and 17 have been prepared. Fig. 15 is the front view, *i.e.*, that nearer the material to be excavated, and Fig. 16 is the back view. The skin, or outside, is 12ft. 8in. external diameter and made of mild steel plates fastened together by lap joints. Inside this, on the inner side, is the excavator head, which consists of three cross members of girder construction. Steel cutters are attached to the cross members in varying positions and in the centre is a larger cutter of special shape. The head is mounted on a central shaft which is supported by the girder seen in the centre of the rear view—Fig. 16. To the left of and slightly lower than the shaft is an electric motor, which, by gearing, drives the internal spur rack wheel bolted to the excavator head. On the cross members are buckets which scoop up the material excavated by the cutters, and it is dropped into the chute seen on the right of the shaft in Fig. 16. From the chute the material falls into the container on the extreme right of Fig. 17, whence it is conveyed by an endless band to the other end of the conveyor and dropped into skips which take it away. Usually there are two pairs of rails and two skips side by side and the conveyor feeds the skips alternately.

The skin carries on its inner side twelve hydraulic rams, controlled by the air-driven hydraulic pressure pump carried by the belt conveyor carriage Fig. 17 and connected to the control on the right of Fig. 16 by the india-rubber piping on the right in Fig. 17. Behind the hydraulic pump on the conveyor is the electrical equipment for the motor shield. The conveyor band is driven electrically. When the shield has to travel forward, pressure is applied to the rams, which then impinge against the segments of the last ring of the tunnel and the shield thus propels itself.

The shields for the station tunnels are 22ft. 10in. external diameter and have a 1in. cylindrical skin of 1in. mild steel plates in eleven sections, with butt cover strips for the full length of the shield. It is 8ft. 10in. long from the back end of the skin to the front or cutting edge. The latter occupies 1ft. 10in., the shield body 3ft. 3in., and the remainder, called "the tail," is for the rams to work in and for the sections which are to be built. The cutting edge is made of twenty-two cast iron segments, as is the shield body, and to the latter are attached twenty-two hydraulic rams. Two working platforms, each in three sections or tables, are carried by, and slide on, horizontal girders which form the bracing of the shield. Each section of platform is provided with an hydraulic ram, which is kept under a constant pressure of 700 lb. to 800 lb. per square inch. These rams move the tables forward and keep them up to the face.

As a consequence of the greater diameter of the station tunnel sections the segments cannot be as readily handled as those of the running tunnel section. Two hydraulic mechanical erectors are therefore provided, which move either in a circular or a radial direction and which lift the segments off the working platform, swing and lift them to the necessary height and position and hold them there until fixed. The twenty-two circumferential rams are 7in. diameter and have a 2ft. stroke and are capable of exerting a pressure of 2400 lb. per square inch.

The excavated material is, as already said, deposited into skips which are drawn by miniature gauge locomotives driven electrically by power derived from either an overhead line or from self-contained batteries.

The Structural Design of Electric Traveller Crabs.

By E. G. FIEGEHEN, M.I.Mech.E.

The fundamental requirements of a structural crab frame are that it should, in an economical and efficient manner, transfer the loads imposed upon it by the load, together with its own weight, &c., to the supporting rail wheels upon which it travels. Among secondary requirements we may notice :—

(1) The desirability of securing a reasonably short "hook approach" at each end of the crab travel, thus extending the floor area served by the crane.

(2) Equalisation of rail wheel loads as far as the design permits.

(3) Conformity to headroom limitations.

(4) Isolation of the crab bearings and gearing from unsymmetrical loadings due to structural deflections.

(5) Convenient support for motors and gearing.

In the case of a crab mounted upon lattice girders the relation of the crab wheel base to the panel length of the girders may call for careful consideration to secure economy and rigidity.

Figs. 1 to 7 indicate a few typical lay-outs for crabs of small and great capacity. In all modern designs the principle of vertical lifting is incorporated, the hoisting barrel being grooved to lift on two parts of rope, coiling right and left-handedly, to secure this desirable feature.

This arrangement ensures an even distribution of load upon the bridge girders so that, to fulfil requirement (2) above, we have only to arrange as far as possible for the centre of gravity of the suspended load to fall on a vertical line equidistant from the crab axles.

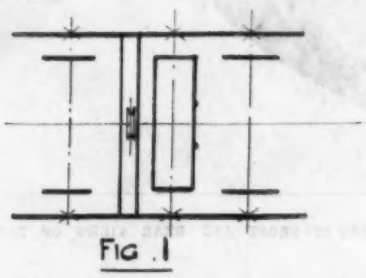


FIG. 1

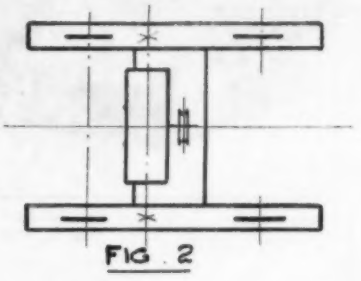


FIG. 2

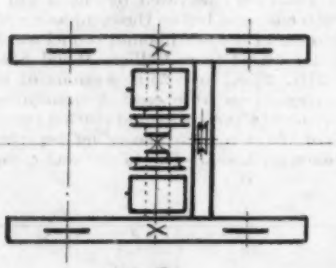


FIG. 3

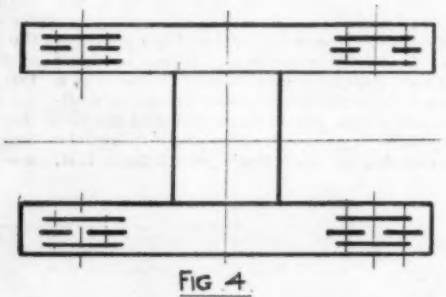


FIG. 4

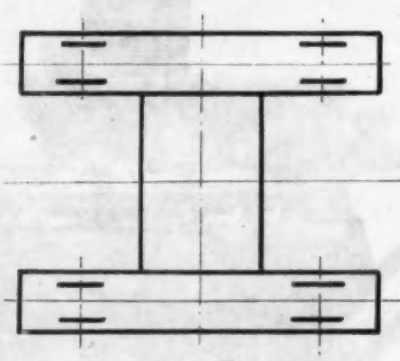


FIG. 5

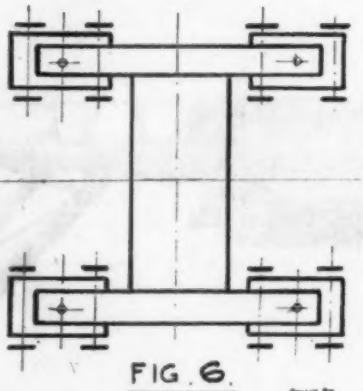


FIG. 6

Fig. 1 illustrates a simple form of structure for crabs of moderate capacity running upon four rail wheels. It is seen to consist mainly of two longitudinal girders bearing upon the crab axles and of a transverse girder supporting the equalising rope sheave.

The hoisting barrel, in this design, itself constitutes a girder transferring its burden to the longitudinal girders. Subsidiary girders will be required to support motors and gearing and the design should incorporate sufficient rigidity to prevent distortion in the horizontal plane out of squareness. The distorting forces in this direction, however, are likely to be small.

Fig. 2 comprises three main girders as before, but here the longitudinal girders are double, generally two channels, and the rail wheels are mounted upon short axles, either of the fixed or the running variety.

As compared with Fig. 1, the axles may usually be of smaller diameter, being more favourably loaded. It is necessary, of course, to provide a shaft to connect the opposite driving rail wheels torsionally, but this shaft will be lighter than the equivalent continuous driving axle in Fig. 1. Alternatively, the driving wheels may be individually geared and connected by a cross pinion shaft.

Between the short trailing axles no such connection is necessary, and consequently the intermediate space thus made available may be usefully occupied by other details ; this possibility is generally of great value to the designer.

Comparing Figs. 1 and 2, the latter is undoubtedly more expensive, both structurally (on account of the more numerous joints) and from the fact that here, unless fixed axles are preferred, eight axle bearings are required instead of four. In the fixed axle design two pairs of final drive gear wheels are needed instead of one pair only. Fig. 2, however, lends itself more readily to reduction in the total height of the crab when headroom is limited.

When, owing to increasing capacity, more than four falls of rope are necessary to support the load, the position and support of top running sheaves becomes a problem, for it is generally undesirable that the presence of these sheaves should limit the lift of the snatch block, that being a defect of many designs otherwise excellent. Space for such return sheaves can be found in the centre of the crab at a high level if the hoisting barrel is divided into two separate units as shown in Fig. 3.

Up to capacities of 30 tons or so it may be feasible to provide a running barrel shaft of suitable diameter to which both barrel units are keyed, one of the barrels only being provided with a spur driving ring, whilst an intermediate bearing, resting upon a beam directly below the barrel, provides the necessary central support for the barrel shaft. Close up to this bearing, on both sides, the return rope sheaves run loose on the barrel shaft.

In crabs of greater capacity the size of such a driving barrel shaft would become excessive and the general construction unsuitable, and then a fixed barrel shaft may be adopted, supported in the centre by the transverse girder, a plate extension being provided, on each side of which the return sheaves are placed as before. In this development the two barrels must each have spur driving rings and these are driven in unison by a cross pinion shaft.

It is not usually feasible to adopt rail wheels of liberal

diameter for traveller crabs, owing principally to restrictions of space and consequently, as the capacity of the crab increases, there comes a stage where four wheels are inadequate for the duty of supporting it.

A further consideration is that very heavy wheel loads constitute load concentrations on the cross girders that induce heavy shear stresses in the riveting and secondary bending stresses also in the top chord of a lattice girder when this type is adopted. It, therefore, becomes necessary to increase the number of supporting wheels, generally to eight, for a six-wheel lay-out is not generally suitable.

In arranging eight wheels we can either adhere to the single rail on each cross girder and arrange two two-wheel frames on each side of the crab as shown in Fig. 4, or we can provide two rails on each cross girder (generally situated immediately over the two parallel webs of a box girder design) and provide four short axles, each with two wheels as shown in Fig. 5.

A still further development is the sixteen-wheel design with four four-wheel bogies, as shown in Fig. 6, again using two rails upon each cross girder.

Fig. 7 illustrates an interesting development in crab design wherein the lifting ropes fall direct from the barrels outside the two main girders instead of between them, as usual. The axes of the barrels may be parallel with the main girders as shown, or at right angles to them. Alternatively, the barrel or barrels may be placed near the centre of the crab, the ropes from them then being led over guide sheaves. In both cases the ropes are led to snatch blocks, which in turn are attached to a transverse lifting beam below the girders.

The advantage of the arrangement lies in the possibility that it affords for bracing the main girders together transversely to form a lateral girder construction rigid in its resistance to bending due to horizontal inertia forces, and adapted, furthermore, to support a platform without the use of auxiliary supports, as usual.

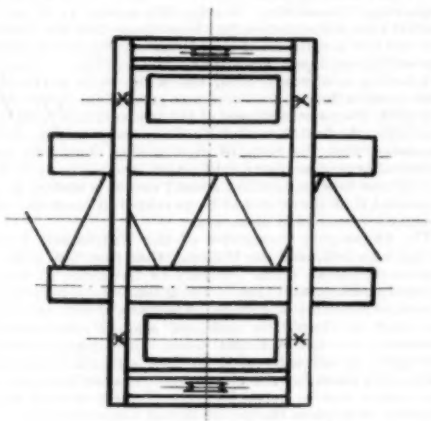


FIG. 7

In cranes of small capacity and of long span this braced construction is very economical and satisfactory, although some height of lift is necessarily sacrificed, for the lifting beam cannot, of course, rise higher than the level of the bottom of the main girders.

In ladle crane designs the transverse bracing is of limited depth, and space is then available below it to allow for the passage of an auxiliary crab, which runs upon rails secured to the lower flanges of the main girders, thus making a very compact and satisfactory design altogether.

In designing crabs for minimum headroom requirements, the depth of the main structural members may often have to be kept small, but it is important that the desirability of adequate rigidity should not be overlooked and low unit stresses should therefore be adopted. As a further precaution bearings of the self-aligning type are desirable.

In some designs the diameter of the barrel spur ring is not much greater than that of the barrel itself and the pitch line load is correspondingly high. If the ropes fall from the barrel on the same side as the pinion the pressure upon the barrel shaft bearing on the geared side may be almost entirely relieved when hoisting. This will modify the bending moment on the adjacent side girder of the crab and the deflection here will be less than on the opposite side, causing a distortion which, although small, may be appreciable from the standpoint of satisfactory gear contact if the section lacks rigidity.

Lack of rigidity in the transverse girder system will result in a corresponding inclination inwards of the side girders, and that also is detrimental to bearing and gear contact and must be kept as small as possible to ensure satisfactory operation.

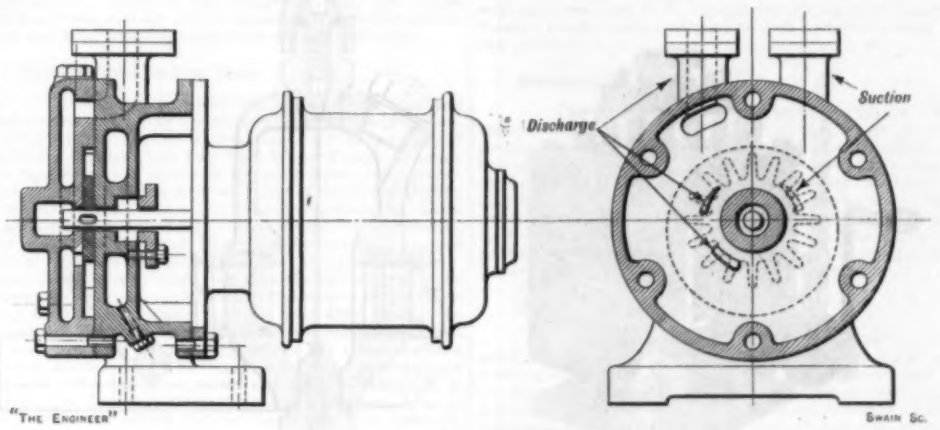
Shallow beam members are difficult to connect in a satisfactory manner, and even small deflections constantly repeated are capable of loosening the bolts that connect castings to a structural framework; it is useful to remember that, for a given loading, the stiffness of a beam increases as the square of the depth, and that therefore every additional inch in depth represents an appreciable gain in rigidity.

A Self-priming Centrifugal Pump.

The sketch which we reproduce herewith gives some idea of the construction of a little pump, which we recently inspected at the South Kensington Science Museum, and which embodies a rather novel feature.

This pump, which is supplied by Siemens-Schuckert (Great Britain), Ltd., of 109, Kingsway, London, W.C. 2. has the outstanding merit that it is self-priming, and will even continue to operate when it is sucking a considerable proportion of air with the water. The impeller, it will be seen, has plain star-shaped vanes, and is arranged excentrically in its casing. There is an inlet on one side of the vertical diameter and two outlets on the opposite side. These two outlets communicate with one another, and it would appear that the pump would be equally effective with either one, but we have failed to get an explanation as to the reason for the adoption of two outlets.

As a plain centrifugal pump, the action of the machine is fairly obvious, but its ability to suck air perhaps needs a little explanation. It will be noticed that the outlets are placed radially some distance from the periphery of the casing, with the result that some of the water is always retained and whirls round with the impeller. Supposing that no water comes up the suction pipe, the water in the casing will form an annular ring round the impeller with voids in the spaces between the vanes. On account of the excentricity of the impeller, these spaces will increase progressively on the suction side of the vertical diameter, and decrease again on the delivery side. There is consequently first a sucking effect and then one of compression, which produces a vacuum in the suction pipe and makes the pump self-priming.



THE "ELMO" SELF-PRIMING CENTRIFUGAL PUMP

The pump, to which the name of Elmo has been given, is made in several sizes, and is put forward for such services as house supplies or drainage, where it may have to work intermittently and be controlled automatically, and where certainty of action is of more importance than high efficiency.

The Fineness of Coal Dust.

In examining the problem of coal dust explosions the most important factors, with respect both to the ignition of coal dust and the propagation of flame in a dust cloud, are the degree of fineness, the shape and the distribution of the particles of dust in the cloud, and the particular physical quality involved is the specific surface of the dust, i.e., the ratio of surface to mass in the particles of the dust.

The merits of the several methods which can be used for determining the specific surfaces of dusts are discussed in a paper by E. F. Greig entitled "Some Problems Connected with the Determination of the Fineness of Coal Dust" (Safety in Mines Research Board Paper No. 25, H.M. Stationery Office, Adastral House, Kingsway, London, price 1s. net).

We extract the following from the opening section of this interesting paper, in which the author defines the programme to which a student of this subject should work.

"Coal dust is most dangerous when in the form of a cloud. True, it may smoulder when in a heap, and the combustion may then spread, but its most dangerous effects are produced when the combustion of the dust occurs in the cloud raised after the passage of the 'shock wave' which travels in advance of the explosion front proper.

"The action of the wave is exemplified by what occurs when a train passes rapidly through a railway station. It will be noticed that any waste paper lying about is lifted into the air behind the 'shock wave,' the rear edge of the paper rising. The wave by its compression hits the paper down and compresses the air underneath, but under the slight vacuum that follows the passage of the wave over the sheet of paper the air beneath it expands, causing the sheet to lift a little at the rear, when it is caught up by the rush of the air above it. It is conceivable that a piece of paper would remain undisturbed on the ground with a wind blowing over it at a velocity of a hundred miles an hour, provided that the wind was perfectly steady and had risen gradually; whereas the slightest sudden gust of wind would lift the paper up.

"Something of the same kind must happen during a coal dust explosion in a mine. What lifts the dust off the roadway is, in effect, the air trapped within the deposit, and one factor that renders the dust dangerous is the amount of air that is thus lying imprisoned between the dust particles lying on the roadway, the timbers, and the walls of the mine. For when a pulsating wave passes over the dust the initial part of the wave causes a compression of the trapped air, whilst the release of pressure that follows gives the air below the dust a chance to expand. It is to be noticed that, with a continuous current of air of constant velocity no dust will be raised from a road. It is the gusty wind that raises a cloud. This is due to the fact that in a pulsating fluid the pressure varies inversely as the velocity. Where the air moves fastest, there the air, caught in the pile of dust, expands most. Once a particle is brought into the path of the moving air, if large it will behave as an aerofoil (like an aeroplane wing), or, if small it will behave as the disperse phase of an aerosol (like dust particles in smoke).

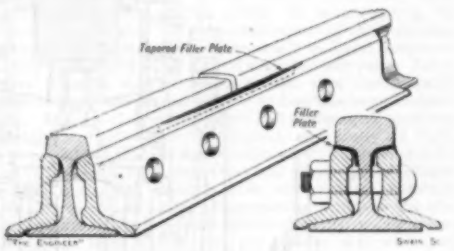
"These facts suggest that it might be possible, where large accumulations of dust exist, to diminish the danger of cloud formation by displacing the entrapped air, not by wetting the top layers, but by allowing a liquid to percolate from below or from one side. Soaking a pile of dust from the top merely drives the air further down into the mass, under greater compression, and may keep it imprisoned underneath. It is therefore of considerable interest to the worker on safety in mines that bulk density measurements should be made on coal dusts. However empirical they may be as a measure of the fineness of the dust, they are a measure of the air contents of the sample of dust considered, and, as such, a measure of the cloud-forming possibilities of the deposit."

As the result of the discussion it is concluded that sieveing methods are not sufficiently accurate, that air elutriation methods provide means of obtaining grades of dusts of definite ranges of specific surface for the purpose of correlating specific surface and degree of inflammability of a dust cloud, that by a combination of elutriation, sedimentation and microscopic examination, it is possible to grade the specific surfaces of dusts, and that other methods, of a more empirical nature, may be found useful for rapid determination and field use.

Wear Plate for Rail Joints.

A permanent way device which is being introduced on American railways to reduce the trouble with worn rail joints is developed from a makeshift practice in vogue on both European and American railways. In many cases wear of the contact fishing surfaces of the rail heads and fish-plates occurs owing to the movements of the rail heads under traffic. When this wear has once started, it continues to increase, and it is a difficult matter to stop or remedy it without going to the expense of applying new fish-plates.

Gangers and track foremen frequently make a temporary remedy by wedging a piece of sheet iron or a bolt washer into the gap between the plate and the rail head. This plan has been improved upon by the American Fork and Hoe Company, which makes railway and other tools, by the introduction of a forged steel filler plate which fits between the contact surfaces. This plate is 9in. to 12in. long, with a maximum thickness of about $\frac{1}{16}$in. to $\frac{1}{8}$in. for a length of 2in. or 3in. at the middle, and then tapering to the thickness of about No. 20 gauge sheet metal at the ends. It is $1\frac{1}{2}$in. in width, and is bent to an angle shape, so that it is securely held in position, as will be seen from the accompanying illustration. The length and thickness vary according to the design of rail joint and the amount of wear between rail and fish-plate. This device is applied easily by the track men, and is claimed to be an economical remedy for a rather frequent trouble.



Another of the unfortunate accidents to motor cars when traversing occupation crossings happened recently on the Liverpool–Southport line of the London, Midland and Scottish. It is said that the motorist, who was killed, opened the near-side gate and ran his car on to the crossing. He then stopped, alighted, crossed and opened the further gate and had resumed his seat in the car when a passenger train approached which ran him down. Two comments are necessary in this case:—(1) It was an occupation and not a highway crossing, and therefore was used at the motorist's own risk; (2) the railway company requires the owners of such crossings to open the further gate before the near one, so that there shall be no need to stop on the crossing.

A High-pressure Locomotive Lubricator.

We recently had an opportunity of dismantling and inspecting a new type of forced feed lubricator, manufactured by the Bosch Company, which is being introduced into this country by J. A. Stevens, Ltd., of Upper Rathbone-place, London, W. 1.

The aim of the designers has been to provide a lubricator which will give a positive measured feed, down to the smallest possible quantities and give that feed against a pressure of 200 atmospheres or so, if necessary. As evidence that they have been successful in their efforts,

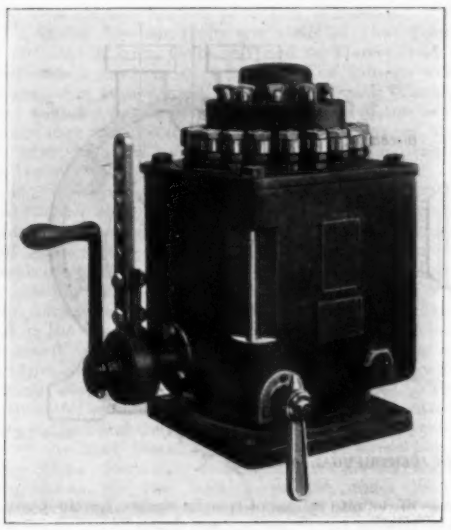


FIG. 1—BOSCH HIGH-PRESSURE LOCOMOTIVE LUBRICATOR

the makers inform us that they have had one of the instruments running for 11,000 hours against a pressure of 300 atmospheres without any appreciable wear. One of the chief reasons which, they assert, has contributed towards this result is the high degree of accuracy which is insisted on in the shops, the limit of inaccuracy allowed in the principal parts being $^1/_{2000}$ mm.

The general arrangement of the device is rather unusual and is worthy of description. On reference to the half-tone engraving—Fig. 1—and the line drawings—Figs. 2, 3 and 4—it will be seen that the mechanism is enclosed in a rectangular case, which forms a reservoir for the oil, and is filled through a strainer at the top. Up the centre of this box there runs a shaft which is driven by worm gearing and ratchet gear, from any convenient moving part of the engine, at a speed of about 20 revolutions per minute. Round this shaft there is grouped a set of pumping units, each of which is provided with two outlets, so that in the case of the lubricator we inspected there were ten pumps and twenty outlets. The number of deliveries can, however, be reduced, as will be described later.

The several units—marked A A in Fig. 2—are fixed to the cover of the box by extensions of the outlet unions, and are held together at the bottom by a circular plate. It is consequently a simple matter to disconnect any single unit and slide it out radially, if it requires attention. Each unit is provided with a pumping plunger B and a valve plunger C. These plungers, which are 8 mm. in diameter, are ground with the high degree of accuracy already mentioned, and we tried unavailingly to force one of the plungers down against the imprisoned air. It will be noticed that the two plungers are operated by two scroll-shaped cams on the central shaft. The drive for the valve plunger needs little comment, but that for the pump requires a little explanation, as it provides for variation in the amount of oil delivered.

In an enlargement of the bore, above the pump chamber, there slides a block D, which hooks loosely on to the pump plunger, so that there is no liability for the plunger to be driven out of alignment. In the side of this block there is a notch which engages with the scroll cam and forces the plunger down. It will be observed that there is sliding friction between the plungers and their cams, but as these parts are of hardened steel, and as they are constantly flooded with oil, they work quite satisfactorily for long periods. The upward or suction stroke of the plunger is effected by a screw which bears against the top face of the

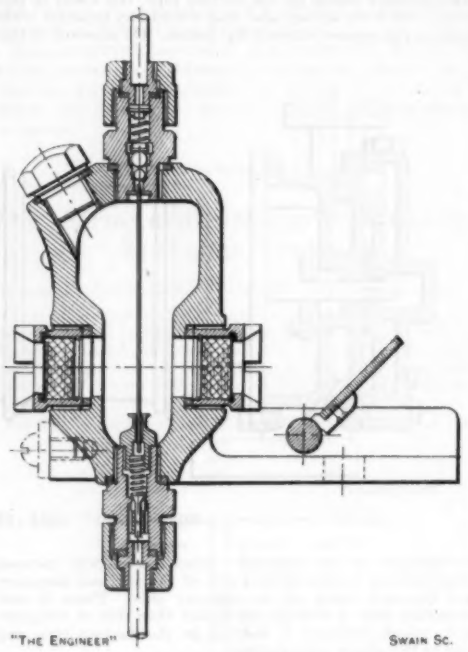


FIG. 5—SECTION OF SIGHT FEED

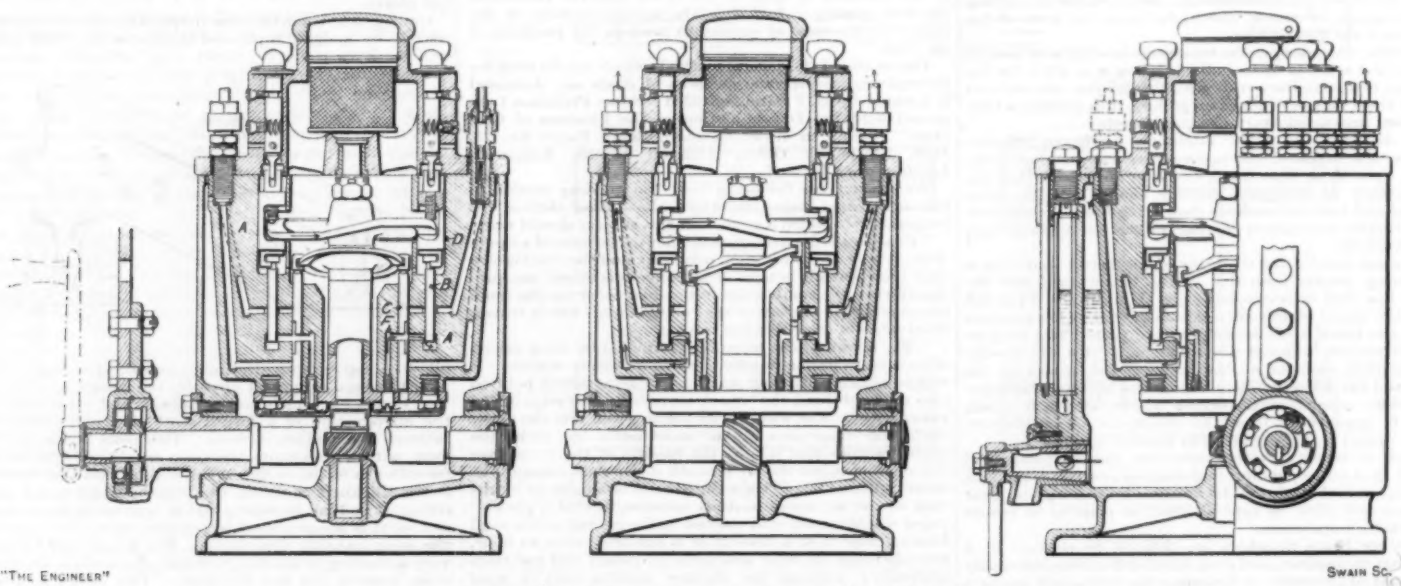
cam. This screw can be screwed in and out of the block D, to provide a certain degree of lost motion between it and the cam, and thus vary the stroke of the pump from zero to a maximum of 8 mm. The screw is set by means of the thumb piece protruding through the cover, which has a pointer that enables the stroke to be set in gradations of $\frac{1}{4}$ mm., or 0·0125 c.c. per stroke.

The two deliveries from each pump are provided for in the following manner. During the suction stroke of the pump plunger the valve plunger is at the centre of its stroke—as shown in Fig. 2—and oil goes up the passage F. through a port in the plunger and into the pump cylinder. The valve then quickly moves to the position shown in Fig. 3, and when the pump plunger descends the oil is forced through a longitudinal passage in the valve and away to the outlet union through a passage drilled in the unit casting. It will be noticed, in this connection, that the cams are formed with quickly rising faces and flat lands to synchronise the various movements. On the next suction stroke the valve moves to the central position again, and then goes to the bottom—see Fig. 3. The pump then forces the oil out by an alternative passage. In Fig. 3, it will be noticed, however, that no outlet union is provided. Instead there is a short plug, which uncovers a port and allows the oil to spill back into the reservoir. In this way the second stroke becomes idle, and only one delivery is supplied by the pump. A union can, nevertheless, be fitted in the place of the plug, as shown in Fig. 2, and then the two deliveries are supplied with oil alternately by the one pump. It is obvious that the adjustment for quantity holds good or both deliveries.

A spring-loaded non-return valve is fitted in each delivery and a strainer is arranged to guard the suction passages. At one corner of the casing—see Fig. 4—there is a gauge glass to show the height of the oil, in connection with a three-way cock that can also be used to drain the container.

These lubricators are so positive in their action that it is generally considered unnecessary to fit sight feeds in connection with them, but if they are desired the type shown in Fig. 5 is recommended. It comprises a strong gun-metal casting partitioned into as many compartments as there are feeds. Each compartment is fitted with glass bull's-eyes to show the oil rising through the water, and a little reflector behind helps in illuminating the interior. The oil first passes through a non-return valve and goes out at the top past two balls. In this way, we are told, there is hardly ever any likelihood of the water being wholly displaced by the oil and the view become obscured. It will be noticed that a fine wire is provided to conduct the drops straight upward.

The lubricators are made with several groupings of deliveries, but are otherwise thoroughly interchangeable.



FIGS. 2 TO 4—ARRANGEMENT OF HIGH-PRESSURE LUBRICATOR

Institution of Fuel Technology.

At a meeting of the Institution of Fuel Technology held at the Institution of Civil Engineers on Friday, July 30th, 1926, to consider and, if approved, adopt the constitution prepared by the Organising Committee, the chairman, Sir William Larke, gave a short *résumé* of the work of the Organising Committee. During the course of it he explained that a suggestion had been made that the Institution and the Institution of Fuel Economy Engineers should, if possible, combine. Correspondence had been exchanged and a long conference held, but while both parties had made every effort to find common ground for joint action, and while the meetings were of the frankest and friendliest character, the Institution of Fuel Economy Engineers had stipulated that the basis of membership should be some technical or professional qualification, and so that membership of the new Institution should confer a status, it was requested that there should be provided at least one class of definitely qualified members.

The Organising Committee of the Institution of Fuel Technology felt, said Sir William, that that was a fundamental difference quite contrary to the sense of the inaugural meeting, and that it would limit the sphere of usefulness of its own institution. The basis of the movement was that it should be national and all embracing in character, so that it might secure the support and co-operation of all interested in fuel and fuel problems. There was room for the closest co-operation between the two bodies, and he hoped that the Councils of both would continue to explore the possibility of ultimate fusion.

It could not be too strongly emphasised, continued Sir William, that the objects of the Institution of Fuel Technology were to promote, foster and develop the general advancement of the various branches of fuel technology as an end in itself. To do that it was considered desirable to enlist the support of all those having any interest in fuel, and not to limit membership by any restrictions as to technical or professional qualifications, but to maintain the prestige and standard of the Institution by the character and nature of the papers presented under its auspices and by the election of a strong Council representative of all interests. The constitution had been so designed as to secure facilities for co-operation with all existing institutions having fuel interests. It had been proved conclusively, he claimed, that there was need for an institution which would bring all sections of workers in fuel and fuel problems into a closer relationship.

The name "The Institution of Fuel Technology" was adopted by the meeting as the name of the new organisation. In moving the resolution that the constitution be adopted, Sir Richard Redmayne called attention to the power given in the articles to the Council "to invite other institutions of bodies not exceeding ten in number interested in the objects of the Institution to nominate a representative of each to membership of the Council." He emphasised the fact that the keynote of the Institution was "Co-operation" and not "Competition." Its work

did not, he maintained, overlap the work of the other institutions, but supplemented it. There was a great field of usefulness before the Institution, possibly the greatest that lay before any technical society in the country at the present time. Cheap fuel was the basis of our national prosperity, and to use fuel to the best possible advantage it was necessary to utilise not only expert knowledge available in this country, but all that knowledge and experience had taught in other countries, and particularly to secure and encourage the application in practice of the results of scientific investigation and research.

THE LOSS OF THE SHENANDOAH.

MUCH has been written about the disaster to the United States airship Shenandoah, and many explanations put forward to account for the accident; but the following, taken from the monthly journal of the Engineers' Club of Philadelphia, seems to us one of the most lucid so far published:—

"The designs of the Shenandoah were begun in 1919 and were approved by a technical committee composed of scientists and engineers of national reputation. In its design approximately 4 per cent. more of the total lift was assigned to the hull structure and fittings than in comparable foreign designs. The airship was built at the Naval Air Station, Lakehurst, and completed in 1923. Finally completed, the weight of the ship exceeded the designed weight by approximately 1 per cent.

"Prior to her last flight the Shenandoah had cruised about 740 hours in the air, covering 25,835 miles over land and sea. These figures would have been considerably larger if sufficient helium to operate the ship at all times had been available.

"It was found by the Court of Inquiry that the final destruction of the Shenandoah was due primarily to large, unbalanced, external, aerodynamic forces arising from high-velocity air currents. She first rose to a height of 3150ft., was steadied at that level for six minutes, then rose again and more rapidly to 6100ft. in ten minutes, dropped to 3000ft. in three minutes, and finally rose again, sharply up by the nose, to probably 3700ft., at which point the ship broke. This last rise was accompanied by a movement of rotation of the whole ship in a horizontal plane and by violent rolling and pitching.

"Deterioration of structural material was found not to be a direct or indirect cause of the loss of the ship. The first break in the main structure of the ship occurred abaft the point of suspension of the control car, which separated the ship in two parts. In less than a minute thereafter the control car broke loose from the forward section and dropped to the earth. About the same time the second break occurred in the after section of the ship, about 30ft. from the broken end.

"Although the disaster to the Shenandoah indicates that a rigid airship can probably be destroyed through external aerodynamic force only, and that such forces can arise from air currents unaccompanied by visible signs recognisable by aerologists in the present state of knowledge, it was the opinion of the Court of Inquiry that such conditions and combinations of circumstances are unusual, and such a conclusion does not therefore throw doubt upon the safety and utility of rigid airships to a materially greater degree than does the fact that other types of craft for navigation in the air or on the water are likewise subject to destruction through unusual danger which cannot be foreseen and provided against. This disaster, said the Court, is part of the price which must inevitably be paid in the development of any new and hazardous art."

INSTITUTE OF METALS: LIEGE MEETING.

AT the Liége meeting of the Institute of Metals, which is to be held from September 1st to 4th next, and a programme of which was given on page 45 of our issue of July 9th last, the following papers will be submitted:—

(1) Dr. C. J. Smithells, H. P. Rookaby and W. R. Pitkin, "The Deformation of Tungsten Crystals";

(2) Professor Kôtarô Honda, "A Comparison of Static and Dynamic Tensile and Notched Bar Tests";

(3) C. H. M. Jenkins, "The Constitution and the Physical Properties of the Alloys of Cadmium and Zinc";

(4) H. J. Gough, S. J. Wright, and Dr. D. Hanson, "Some Further Experiments on the Behaviour of Single Crystals of Aluminium under Reversed Torsional Stresses";

(5) Buntaro Otani, "Silumin and its Structure";

(6) G. Brinton Phillips, "The Primitive Copper Industry of America: Part II.";

(7) Kathleen E. Bingham, "The Constitution and Age-hardening of some Ternary and Quarternary Alloys of Aluminium containing Nickel";

(8) Dr. A. G. C. Gwyer and H. W. L. Phillips, "The Constitution and Structure of the Commercial Aluminium-silicon Alloys," with an Appendix upon "The Properties of the Modified Aluminium-silicon Alloys," by Dr. D. Stockdale and I. Wilkinson;

(9) J. D. Grogan, "Some Mechanical Properties of Silicon-aluminium Alloys";

(10) Dr. Cyril S. Smith and Professor Carle R. Hayward, "The Action of Hydrogen on Hot Solid Copper";

(11) Captain F. R. Barton, "The Development of the Use of Nickel in Coinage";

(12) A. Pinkerton and W. H. Tait, "Season-cracking in Arsenical Copper Tubes";

(13) Professor P. Chevenard, "Thermal Anomalies of Certain Solid Solutions";

(14) W. T. Cook and W. R. D. Jones, "Preliminary Experiments on the Copper-magnesium Alloys";

(15) F. W. Rowe, B.Sc., "Bronze Worm Gear Blanks Produced by Centrifugal Casting"; and

(16) L. Boscheron, "An Account of the Non-ferrous Metals Industry in the Liége District."

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Market Position.

THOUGH work has been resumed this week at many of the engineering establishments in the Midlands and Staffordshire, there has been little activity in the iron and steel market. Transactions have been few and for small tonnages, and have afforded little test as to market values. Neither producers or consumers are inclined to negotiate forward business, and the former's inability to give early delivery, either of iron or steel, limits business considerably. Most of the ironworks, mills and forges remain closed, and the date of resumption is problematical. Iron and steel masters hereabouts are not optimistic.

Strike's Effect on Iron Trade.

The extent to which the Midland iron and steel trades have been hit by the miners' strike is clearly demonstrated by the figures of the May–June ascertainment under the Midland Iron and Steel Wages Board. Though the figures are not available for publication, it is known that the output of the selected group of firms, the trading of which regulates wages under the sliding scale, has fallen to a little more than a fourth of the average of the preceding four months of the year. Such a state of affairs has not existed since the coal strike of 1921. It was in the corresponding months of that year that the full effects of the upheaval were most acutely felt. The output of seventeen firms for the two months was less than 2000 tons. The figures for May and June this year are not quite so bad as that, but they tell a doleful tale of the ruinous effects of such labour conflicts as that in which we are at present engaged. The damage does not end with the reduction of output, for the ascertainment reveals a sufficient drop in the average net selling price to the extent, it is believed, of about 10s. a ton, to give a reduction of 5 per cent. in ironworkers' wages, which took effect on Monday. However, iron and steel plants are at a standstill, so that for the time being the alteration to the wages scale will make no material difference to either employer or employee.

Mining Situation.

Despite the strenuous efforts being made by the miners' leaders and officials and an intensive week-end campaign, to prevent a breakaway of the Warwickshire and Cannock Chase miners from the strike movement until a national settlement has been reached, the figures of men returning to the pits in this area continue to show a substantial increase daily. The number of men at work in Warwickshire at the time of writing was 5197, an increase of nearly 2000 on a week ago. In the Cannock Chase area there are now 4779 miners of all classes at work, while the number of miners who have returned to work at twenty pits in the Dudley and Sedgley districts, where fuel is being produced, show a further increase, the total being about 450, of whom 195 are at work underground and 80 on the surface—including safety men—at Baggeridge and Himley collieries. About 1000 men are at work in the South Staffordshire coalfield, while miners are also drifting back in considerable numbers in South Derbyshire.

Round Oak Mill Resumes.

Operations were resumed on Monday in the 16in. mill at the Round Oak Iron and Steel Works, Brierley Hill, which have been standing idle since the commencement of the coal dispute. In these times it is a pleasant piece of information. Normally, this mill finds employment for about 200 men.

Raw Iron.

The entire cessation of pig iron production in the Midlands continues, and there seems little prospect of a resumption of activity at any of the Northamptonshire or Derbyshire furnaces, from which supplies are chiefly drawn for the Birmingham market. Since the holidays, the demand for pig has fallen off somewhat. However, users in urgent need of supplies can obtain moderate quantities of iron from the North at about £5 6s. 3d. for No. 3 delivered, a price which, combined with the small requirements, does not make for extensive business. East Coast hematite is offered round about £4 16s. for mixed numbers. Foundries are in a position of increasing difficulty. Some continental irons, said to resemble Derbyshire brands, are almost due for arrival, and though the cost will approximate to Middlesbrough prices, the supply will, to some extent, mitigate against any tension. The scarcity of coke is serious, and as much as £3 10s. delivered is being paid for qualities much below the fuel to which the foundries are accustomed. The foundries are only kept in operation because engineering concerns hesitate to bring their machine shops to a standstill. Many of the smaller Midland foundries are now closed down, or at most are running half time

Steel.

The steel branches are fairly active, having regard to the prevailing conditions. The report that some firms in the North and in South Wales are again producing sheet bars was welcomed by Midland industrialists, who prefer native to foreign material. Against contracts, a fair amount of foreign steel, including soft billets and other semi-finished material, is being delivered in the Midlands; but for now business prices have a hardening tendency. Indeed, many users state that foreign steel is now much more difficult to obtain. The continental works are apparently filled up with orders for billets, sheet bars, &c., for in several instances lately they have declined to quote on 1000 lots inquired for from Birmingham. A number of quotations have been received for various steels, but the continental firms making the offers stipulate that unless the orders are accepted by wire on receipt of the quotation, the material must be regarded as no longer available. A common condition is that joists, plates, &c., will require three months for delivery. Some Birmingham merchants have been more fortunate in getting offers for within six or eight weeks. Steel works generally have very good order books, and in a few cases are willing to book on the basis of standard prices, for delivery after the strike, although this involves some risk. The few mills able to give reasonably prompt delivery require a premium on these figures, usually of £1 10s. per ton. Large steel business is being withheld because of the impossibility of ascertaining costs of production or time of delivery. Constructional engineers are, however, still busy with a certain amount of inquiry, and big contracts are known to be pending. The amount of foreign steel utilised in building work is daily increasing. Users of steel who have hitherto steadfastly refused to use foreign material are now being prevailed upon to do so. A number of Midland re-rolling mills have now decided definitely to close down until more suitable fuel is available. The common slack and mixtures now to be bought are giving very unsatisfactory results both in regard to cost and the quality of the product.

Manufactured Iron.

The situation in the Staffordshire finished iron trade is unchanged so far as actual production is concerned. The ironworks are closed. It is still possible to buy wrought iron from Lancashire, where fairly heavy stocks of Crown bars were accumulated before the stoppage and where to some extent production is maintained, but prices are so high as to be almost prohibitive. Attempts to produce bars with the use of continental coal have not proved successful. Continental No. 3 iron is supplying the needs of nut and bolt makers in this area.

Galvanised Sheets.

The galvanised sheet trade continues active, with good bookings and plenty of inquiries. The mills are running chiefly with foreign steel. The improvement in the franc has been followed by a stiffening of continental quotations for sheet bars. They are now quoted at £5 15s. delivered, but even at this figure they are taken up readily by sheet makers. Local mills are asking £17 for 24 gauge corrugateds for forward delivery and £17 10s. for delivery in a fortnight.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

A USEFUL pointer to the prospects of many branches of the engineering industries has been furnished on the Stock Exchange here during the past few days, the shares of several concerns having received quite an appreciable increase in the measure of support and quotations hardening as a result. There can be no doubt that the outlook for a good many firms is better now than it has been for some time, although, of course, the general effect of the improvement in prospects cannot be registered until a settlement of the coal trouble is reached and productive conditions are again something like normal. As has already been indicated in this column, Lancashire constructional engineers are quite satisfactorily placed as regards orders, the great difficulty being to secure supplies of materials. The latest addition to the work in hand in this section is the contract for the steel work for a generating station which Oldham Corporation is erecting, Messrs. Edward Wood and Co., of the Ocean Ironworks, Manchester, having secured the order. It is interesting, by the way, to note that in the annual report of this company just issued, it is stated that the work in hand surpasses in value that at any other period since the war years. Locomotive firms in this area also benefit very considerably by the orders just placed by the Indian Railway Department. Makers of electrical plant and equipment, speaking generally, are satisfactorily situated, and many of them are hopeful that the serious trouble which has been the lot of most power users through the coal stoppage will stimulate the industrial electrification movement, especially in respect of cotton mills. Engineering works in the district that are using imported fuel are having to pay prices which range from 55s. to 60s. per ton for coal which, at the best, is of relatively poor quality.

Non-ferrous Metals.

In the non-ferrous metal markets during the past week tin has continued its firmness, and the expressed belief in the strength of the statistical position seems to be justified by a published estimate of the month-end figures relating to visible supplies, these, it is said, showing another marked reduction at the end of July. The market was well supported by speculative buying, and good quantitives have also changed hands for trade consumption. The net result has been that the quotations at the time of writing represent a further advance compared with a week ago, and remain very firm and within comparatively easy reach of the £300 per ton of which the trade has been talking for some weeks. Copper also finishes up on a steady tone, although not much changed on balance. The latest reports are that the difficulties which hitherto have stood in the way of the active formation of the United States Copper Export Association have now been overcome, although we are not told when it is actually going to begin to function. On more than one occasion during the last month or two, the market has acquired wonderful strength on reports of the "day," but each time a postponement has had to be announced. Lead has met with a fair demand and closes steady. Spelter, however, has been rather quiet, although little if any ground has been lost since last report.

Iron.

Except for a marked advance in the prices quoted on this market for anything that has been offered, there is little that can be said regarding the iron trade. So far as the leading makers who are represented here are concerned, there has been no attempt at resuming production,

and most of them seem content to utilise their fuel supplies for the purpose of maintaining the furnaces on low blast. From the point of view of supplies the situation seems to have taken a distinct turn for the worse since last I wrote, for during the last day or two prices quoted here have undergone a substantial advance. There are, of course, still no Staffordshire, Lincolnshire, or Derbyshire brands to be got, and apart from a few odd lots of special irons offers are confined to Scottish and Middlesbrough No. 3 and hematites. A week ago both of the former could be bought at from 100s. to 102s. 6d. per ton, delivered Manchester or equal distance. Now, however, Scottish is making from 106s. to 107s. 6d. per ton, and Middlesbrough up to 108s. 6d., with hematite offered at about 98s., against 94s. a week ago. The demand for foundry iron is not important just now, but, judging from the movement of prices, it seems to be of sufficient strength to absorb what little is being offered. Lancashire bar iron manufacturers have not altered their prices, which remain at £11 10s. for Crown quality and £10 5s. for seconds, but so far as actual business is concerned, these are purely nominal. There is not much actual demand, but for available stocks higher rates than the fixed prices of the Association are being asked.

Steel.

Boiler plates and constructional steel work are still subjects of interest in the steel market, but the price problem remains one of very considerable difficulty. There is not much being produced for obvious reasons, but the one or two rolling and re-rolling mills that are working at part capacity are naturally asking higher prices to cover the increase in production costs. In the case of joists and sections and ship plates, for example, one firm is asking about £1 5s. per ton more than the fixed minimum rates, which would bring the current prices to £8 12s. 6d. and £9 7s. 6d. per ton respectively. The same applies to small steel bars, which re-rollers are offering at from £9 5s. to £9 10s. Boiler-plates are nominal at £11 10s. per ton, but users affirm in some cases that they are still in a position to place orders for these at a lower figure. The position of continental materials is anything but clear yet, and certain foreign makers are said to be so well placed for business that they have practically ceased to book any more for the time being. In any event, it is certain that delivery of any kind of continental material, unless special arrangements are made, cannot be effected in less than two or three months. Quotations are higher at £6 12s. 6d. per ton for Siemens plates, £6 to £6 2s. 6d. for ship plates, £5 15s. for joists, and £6 per ton for sections, for cash against documents, delivered to users' works in this area. Galvanised sheets remain firm at up to £17 per ton f.o.b. for Indian specifications for October–November delivery, but the demand is disappointing and below what has been experienced for several years at about this time. There has been some inquiry for thin sheets at £22 5s. per ton for Straits, £23 5s. for Bangkoks, £24 10s. for Shanghais, and £24 2s. 6d. for Rangoons.

Scrap.

Non-ferrous metal scrap has kept fairly steady, although demand is restricted. Best selected gun-metal is offered at £54, cast aluminium at £84, heavy yellow brass at £44 to £45, clean light copper at £56, zinc at £25 to £26, lead at £31 10s., and brass rod turnings at £39 10s., for graded materials, delivered to consumers' works. Iron and steel scrap remain very dull and nominal.

BARROW-IN-FURNESS.

General Conditions.

The iron trade is practically at a standstill. Now that the holidays are over there is a very small inquiry, and what small stocks exist are being gradually reduced to zero. The district is simply waiting for a settlement in the coal dispute, so that it may get to work again, when it is hoped to do more business than was done for many months before the stoppage. The ore trade is in a similar state, and although all the mines were not idle before the holidays, there was not much being brought up. In the steel trade there is a restart in the hoop works, where foreign billets are being used.

Shipbuilding and Engineering.

The shipbuilding and engineering trades restarted on Tuesday, and there is no likelihood of there being any stoppage at Vickers, for there is now plenty of foreign coal coming into the port. As regards coal imports there have been several more cargoes discharged at Barrow, and last week there arrived cargoes of coal from Norfolk, Va.—two—Newport News, Rotterdam and Hamburg. Much of this coal is carried by the railway to industrial centres within a radius of a hundred and more miles from Barrow.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Position.

SHORTAGE of steel supplies is causing many engineering firms more difficulty than is the shortage and costliness of fuel. For more than three months there has been a steady drain on stocks, and they are rapidly approaching exhaustion. From the point of view of those firms which have had a lot of money lying idle in the form of heavy stocks, much heavier than is desirable, this opportunity of utilising them has been of value, but holdings have now been so far reduced that some searching round for supplies has become necessary. This is where those engineering firms which are allied with the big steel makers have the advantage, as they are naturally getting the first consideration. Melting ceased at the beginning of May, and the fact that supplies have lasted out until now is in itself a matter for some surprise. It only shows how badly Sheffield trade has been hit during the last few years, otherwise so much material would not have been added to stock. Of course, a good many departments have had to close down, generally those which are big consumers of steel and fuel, but the trade of the city has not been brought anywhere near a standstill yet. Indeed, some firms which are favourably placed for getting supplies of raw and semi-finished material have hardly eased any of their activities. All this continued effort means the exercising by the controlling heads of a great amount of enterprise and ingenuity. The great aim has been to keep the works going, and the extent to which manufacturers have succeeded is really remarkable.

Danger of Lost Orders.

At the moment there is a fair amount of work in hand, but every week brings evidence of lost orders. Many of Sheffield's oversea customers have been very patient, but with firms unable to promise delivery, and with a settlement of the coal dispute still apparently far away, it is not surprising that customers are listening to the offers being made by this country's steel rivals. One gentleman who has been associated with all branches of the Sheffield steel trade for a quarter of a century states that our losses are the gain of America and Germany. "Those countries," he adds, "are not slow to seize advantages which the markets offer, and for which we are unable to continue to bid." One of the departments which is going to be most severely hit is that producing heavy railway material. Practically ever since the war the Sheffield and district railway engineering plants have been making a desperate fight to lessen the advantages continental competitors have had in quoting for business. Just when substantial headway was beginning to be made came the present trouble, and its effect upon colonial, and particularly upon Indian and South American trade, will be little short of disastrous if the coal stoppage continues much longer.

Large Rail Mill Restarted.

Isolated items of good news continue to be received. Last week the rail mill of Samuel Fox and Co., Stocksbridge, one of the largest mills in the country, was put into operation again, and a start was made with about a hundred men. By next week it is expected that the activities will have been considerably increased. The works of Fox and Co., who are part of the great firm of the United Steel Companies, Ltd., have been almost completely stopped since the commencement of the industrial trouble. Stocksbridge has been very badly hit, and the news that the mill was to be re-started gave great satisfaction in the district. Lack of coal has been the trouble, but now the company has been able to get supplies from its own pit at Stocksbridge, where about thirty men are at work, and it is also utilising foreign and outcrop coal.

Freer Supplies of Fuel.

Thousands of men are now working on the numerous outcrop seams in the Sheffield, Barnsley and other South and West Yorkshire coal areas, and so great has the output become that selling prices have been reduced and large quantities of the coal removed for the assistance of other centres which do not possess this source of supply. There was no cessation of outcrop working during the holiday, but consumption naturally fell away, with the result that stocks mounted up sharply, and many local works were able to replenish their bunkers without difficulty. Officials of the Yorkshire Miners' Association have become considerably alarmed at the extent to which outcrop mining has developed, and a strong protest has been made. At a demonstration meeting in Sheffield last week, the assistance of Mr. Herbert Smith, the President of the Miners' Federation, was sought, and at that meeting one of the local officials stated that outcrop coal had become a greater menace to the miners' cause than all the foreign coal coming into the country. There are, however, plenty of miners willing to get this coal, and work eight, nine and even ten hours a day. There is no doubt that the influence of this coal on the industrial position of Sheffield and district has been considerable, and with supplies more plentiful there has been less inclination to inquire after foreign coal, a fair amount of which is on offer, but the prices are too high to attract much business. On this point, it is interesting to note that during last month 176,379 tons of coal were landed at Hull, the main port of supply for the West Riding. Of that total, 76,508 tons came from Silesia, 48,246 tons from America, 32,623 tons from Westphalia, and 15,717 tons from Belgium.

Tools, Cutlery and Plate.

So far the coal stoppage does not appear to have adversely affected the lighter trades. Saws, files and edge tools are fairly well employed, but there is a danger here, as in the heavier trades, of raw material running short. The disposition is to postpone the placing of new business, but in spite of this manufacturers display a general feeling of quiet confidence in the future. The position of the cutlery and plate trades is unchanged. No developments or new features are reported. The holiday influence is still being felt, and owing to this and the general uncertainty, little has yet been done towards preparing to meet the coming seasonal trade.

Sewerage Works Contracts.

More and more local authorities are adopting the bio-aeration, or Sheffield, system of sewage disposal, which is in operation at Sheffield, and is the invention of Mr. J. Haworth, the Corporation's sewage works manager and chemist. Chesterfield Rural Council has adopted this system in its sewerage scheme for Staveley, Brimington and Sutton-cum-Duckmanton, and has made a start by accepting the following tenders for 7 miles of sewers and three pumping stations:—Netherthorpe and Poolsbrook, T. Beighton, Brimington, £10,824; Hollingwood, C. S. Tomlinson, Alfreton, £11,373; Barrow Hill, New Brimington and Ringwood, H. and E. Andrews, Crookes, Sheffield, £10,750; the Staveley Company's tender of £12,783 for cast iron pipes was also accepted. The whole of the scheme will cost £90,000. The sewage disposal works of Swinton Urban Council being out of date, it is proposed to adopt the Sheffield system there also, and application has been made for permission to borrow £25,000 for reconstruction purposes.

Electricity Developments.

The half-yearly report of the Electrical Distribution of Yorkshire, Ltd., states that there has been a large increase in the sale of electricity, and the directors have again been able to reduce prices. Further extensions in the operations of the company are outlined. The Electricity Commissioners have approved applications for orders for six new areas of supply in the West Riding, and these are now awaiting confirmation by Parliament. Doncaster Corporation has launched a big scheme for new electrical distribution in the centre of the town and in connection with this is to apply for borrowing powers for £52,700. The Corporation has received permission from the Electricity Commissioners to proceed with the installation of another 6000-kilowatt plant.

Water Supplies in New Areas.

Attention to the demands which will arise owing to further colliery developments in the Thorne and Lindholme districts is being given by the Thorne and District Water Board. At the annual meeting at Doncaster, it was reported that in order to meet further demands it might be necessary to add considerably to the pumping plant and storage tower. The company has received additional parliamentary powers providing for an increase of £32,000 in capital. This, with the £8985 of the original capital still unissued, will, in the opinion of the directors, prove adequate for all possible requirements, whether or not Pease and Partners decide to obtain their water from the company for their new colliery village.

Preservation of Stone.

At the request of the Building Research Board, a section of the Department of Scientific and Industrial Research, Dr. C. H. Desch, Head of the Metallurgical Department at Sheffield University, is supervising experimental work on the weathering of building stones. The extensive decay of the stones used for the Houses of Parliament, Westminster Abbey and other public buildings, has made it a matter of national importance that there should be scientific research to discover, in the first place, what kind of stone can best resist the ravages of the modern atmosphere of industrial cities, impregnated as it is with smoke and chemicals, and, in the second place, to try to find whether any protection can be afforded to existing buildings.

New Master Cutler.

At the annual meeting of the Cutlers' Company of Hallamshire, held at Sheffield on Tuesday, Mr. David Flather was elected Master Cutler, in succession to Mr. T. R. Ellin. Mr. Flather is head of the firm of W. T. Flather, Ltd., Standard Steel Works, Tinsley, and his family has been associated with the industries of Sheffield for many years.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

THE position in industrial circles in the North of England remains unchanged, and whilst quietude in general prevails it is satisfactory that matters are not growing any worse. The wonder is that so much is being done having regard to the obstacles which have to be surmounted. At the same time heavy expense is being incurred to keep plant in operation. There is no lack of foreign fuel, but imports vary in quality. While some cargoes which have arrived have been found to be quite good, others have proved to provide an imperfect heating material which has imposed difficulty in the working of certain iron and steel plants. The cost of importing this foreign fuel, however, is far from covered by the advance in iron and steel quotations, but firms with portions of their works still producing commodities are reluctant to close down altogether. In some cases premiums up to 20s. per ton above the agreed minima have been paid for finished steel materials, but the prices obtained cannot be taken as in any way indicative of the true position of the market. The majority of manufacturers, in fact, do not anticipate an upward movement in quotations when production is resumed on a normal basis, and some are prepared to book orders for delivery after the settlement of the coal dispute at the present agreed minima figures.

Cleveland Iron Trade.

Business of any magnitude in Cleveland pig iron is now entirely out of the question, and it is even difficult to secure small quantities. There is one grain of satisfaction, namely, that stocks of iron, which in some cases had reached unwieldy proportions prior to the coal stoppage, have now been dispersed. When circumstances permit, producers will be able to resume work without the fear of a big accumulation of unsold material. Still that is only a minor consolation. Idle plant means heavy charges, and plant has been idle too long. When the end will come no one can say, but meantime business is very difficult to arrange, and many consumers have ceased to inquire. Four blast-furnaces continue to operate on the North-East Coast, and prices are still unaltered. Buyers, however, protest that prices are too high, and many are buying foreign iron. In general, there is so little material for disposal that makers can get their price for such iron as they have to sell. No. 1 foundry iron is 92s. 6d. per ton; No. 3 G.M.B. Cleveland pig iron, 90s.; No. 4 foundry, 89s.; and No. 4 forge, 88s. 6d.

Hematite Pig Iron.

East Coast hematite pig iron has become very scarce, and buyers must not be too insistent upon special analyses if they want supplies. The basis price, however, is still 81s. per ton for mixed numbers, and 81s. 6d. per ton for No. 1 quality.

Ironmaking Materials.

Blast-furnace coke is nominally around 50s. per ton delivered at the works, and best Rubio ore 21s. 6d. per ton c.i.f. Tees, but there is no business.

Manufactured Iron and Steel.

Sales of manufactured iron and steel are confined to small quantities from stock. It is reported, however, that some firms are contemplating restarting rolling in order to cope with some urgent orders.

The Coal Trade.

The coal trade outlook is unchanged. All inquiries have to be turned down. The export trade for the remainder of the year is daily showing a more discouraging outlook. Advices from various continental and American centres report that European consumers are steadily booking up deliveries over the next three or four months, and when, on this side, operators are able to enter the market again, they fear that only remnants of trade will be available.

Shipbuilding Held Up.

Shipbuilding and ship-repairing is being held up to a big extent at North-East Coast yards owing to the lack of materials, and little work is being proceeded with in the few establishments that remain open. The two large Canadian Pacific Railway vessels, which are to be built by Sir W. G. Armstrong, Whitworth and Co., Ltd., will be constructed at the firm's Naval yard, but it is improbable that they will be begun until after the miners' dispute is settled. The contract for machinery for these ships has been placed with the Parsons Marine Steam Turbine Company, Ltd., at Wallsend. This week Swan, Hunter and Wigham Richardson, Ltd., secured a contract for a twin-screw steamer of about 2000 tons for the British India Steam Navigation Company, Ltd. The ship is intended for the Eastern trade, and will be built at the firm's Neptune Yard at Walker, where several larger steamers have been constructed for the same company. The engines will be supplied by the builders. In this case, too, it is obviously impossible to commence building the steamer until the miners' dispute has ended, for the shipbuilders have now exhausted what reserve supplies of steel they may have had, and even when they are able to place an order, a few weeks must elapse before it can be delivered. New orders, even for small vessels, are, of course, very acceptable in helping the shipyards to keep going.

SCOTLAND.

(From our own Correspondent.)

No Change.

WITH the end of the coal strike still indefinite, general conditions become more and more depressing. With so many works inactive, consumers have to depend on stocks for supplies or purchase from abroad. Home supplies of many steel and iron products are almost exhausted, and prices are stiffening from week to week, while the position is not made any easier by the enhanced quotations for foreign goods. The shipbuilding and engineering industries, along with allied trades, feel keenly this scarcity of materials, and the holding up of contracts consequent on the inability of producers to name delivery dates.

Steel and Iron.

Apart from the light castings works and a section of the steel industry, practically nothing is being done at present. Sheet makers and re-rollers report a good volume of business, sufficient to maintain employment for a considerable period, provided operations can be continued. Increased demands for spelter on home and continental account tend to strengthen quotations and to maintain steel sheet prices on a higher level. Stocks of pig iron are steadily decreasing, and prices for immediate delivery are steadily rising. Practically nothing is being done in scrap. For some time back continental works have been receiving a steady flow of orders for steel and iron materials from this district, but demands are decreasing with the firming of quotations from abroad. Hence, stocks of all descriptions of materials are extremely low, and as these decrease prices are liable to appreciate, but business for definite delivery is on a very small scale. It is said that remarkably few orders have been cancelled, and that there is, in most branches, sufficient work on hand to ensure a good restart when home supplies of fuel are available. Various opinions have been expressed as to the probable trend of prices when normal conditions are restored. Some anticipate an increase, but the majority appear to consider this improbable, as few consumers will consent to pay increased rates. Such impositions would only result in a curtailment of activities or in the sending of orders abroad. Firm prices have certainly been paid recently, but in almost all such instances the quantities involved have been small lots for urgent delivery.

Coal.

There has been little change in the situation in Scotland. There have been further instances of miners returning to work, but the total number now engaged does not exceed 1400, exclusive of safety men. Some of the men have restarted work on pre-strike terms, while others have accepted an eight hours' day at the old rate. Considerable quantities of foreign coal continue to arrive. At Grangemouth every berth is occupied, and several vessels await crane berths. Household fuel has been raised to between 3s. 3d. and 3s. 6d. per cwt. in some districts, due, it has been said, in a measure, to the presence of unusual quantities of dross per ton in the fuel imported.

Imported Fuel and Industry.

The high price of imported fuel limits its use for industrial purposes, but other difficulties have arisen where consumers have been prepared to pay the price asked. It has not been found practicable to utilise such fuel in all cases where mechanical stoking apparatus is installed, owing to the impossibility of obtaining correctly graded foreign coal. In other cases there has been a slowing down of output where heat processes are used, owing to the quality and the lack of uniformity in the fuel supplied.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Dispute Outlook.

IT is regarded as pretty certain that there will be no resumption of work in the coalfield this month, and that being the case, discussion is centred more on the prospects of a settlement being arrived at, so that work can be restarted in September. In some quarters, the opinion is held that the end will come suddenly, but no tangible reason is forthcoming for this view. To all appearances the trouble may easily continue well into next month, and so far as the proposals of the Christian Industrial Fellowship are concerned, no great faith is placed in them as forming the basis of any solution of the problem. The special delegate conference of the South Wales Miners' Federation held on Saturday to consider them, did not take long to come to a decision. In less than an hour it was decided to reject the proposals, the voting being 134 for the proposals and 186 against, the majority against being therefore 52. This was regarded as being sufficiently definite to do away with the necessity of having a card vote. This decision, of course, is in opposition to the policy of the Executive Committee of the Miners' Federation of Great Britain, but even assuming that the proposals meet with acceptance nationally, it is questionable whether the end of the dispute is brought any nearer.

Coal Imports.

Since May 1st it is calculated that well over 350,000 tons of coal have been imported into South Wales ports. Last week the quantity brought in could not have been far short of 100,000 tons, as there were as many as twenty-eight steamers discharging cargoes from America and continental ports. This week the number of boats discharging was a little under twenty. The work of discharging provides welcome employment for considerable numbers of men, who are reported to have been earning as much as £8 and £9 per week. It has been a matter of surprise that the work of discharging has been on such a satisfactory scale. It was thought that the necessary facilities were not available to discharge coals rapidly, but the Great Western Railway Company has disproved this, as steamers have been discharged comfortably at the rate of 800 to 1000 tons per day, and in some special cases as much as 1500 tons per day have been turned out. Fresh cargoes are arriving daily, and negotiations are being continued for further supplies, but continental producers are so full up with orders that it is very difficult to purchase new cargoes for prompt delivery. In the case of German coals, the Syndicate has recently advanced its prices from 1s. to 2s. per ton for all qualities. The continuation of the stoppage of work in this country has naturally been responsible for almost daily reports of lost contracts. It has been stated of late that orders for 400,000 tons of coal for France have been lost by this country. Exactly what business this refers to is not known, though, considering the duration of the trouble in this country, it would be not surprising if such a large quantity of business had been placed elsewhere. This is very likely, as the policy of the Germans in particular has been to sell on favourable terms, provided only that contracts have been entered into for supplies to be delivered over three to six months. There is little doubt that if it were possible to trace all orders, it would be found that owing to the trouble in this country, South Wales has lost business amounting to anything from three to four million tons. There has been no change in the prices for local supplies of large coal and patent fuel for industrial purposes, viz., 45s. per ton maximum. An application from the Cardiff and District Coal Merchants' Association to increase the retail price of coal from 3s. to 3s. 4d. a cwt. has been agreed to by the Cardiff Coal Committee.

Miners Anxious to Work.

In one or two districts of South Wales it is evident that the miners are becoming restless in their long-continued activity. In the Llanharran district, it is reported that over 100 men have resumed work, while another report states that at the Glenhavod Colliery, in the Port Talbot area, about 250 men restarted work on Tuesday morning, while additional workmen were expected to resume on the night shift. Some of the miners' leaders are getting rather alarmed at the position, and are arranging to carry out a campaign in the district, with the object of getting men to hold firm for a national settlement. The general secretary of the Miners' Federation, Mr. A. J. Cook, has been communicated with, and has promised to come down and help the local leaders.

LATER.

The workmen at the Blackbrook Colliery, Caerphilly, were recently asked to resume work on the terms operating before the stoppage, but with the condition that when a national agreement was come to it should be accepted. The men declined at first, but have subsequently shown willingness to work. They, however, failed to get the sanction of the local Committee District of Miners and are therefore approaching the Central Executive. Doubts are held whether they will succeed.

Charge for Wagon Storage.

The Great Western Railway Company has dropped a bomb among wagon owners and users since writing a week ago, by notifying them that as from August 8th it is intended to charge them 6d. per wagon per day in respect of all wagons which remain in storage on the company's railway system. The notice which has been sent out points out that since the commencement of the coal strike on May 1st, no charge has been made for this accommodation, and the view is expressed that it is not reasonable to expect the company to provide free storage accommodation for an indefinite period. The charge mentioned is to apply to all wagons, whether empty or laden. It is estimated that there are about 130,000 privately owned wagons in South Wales, by far the bulk of which belong to the colliery companies. It is probable that about 60 to 70 per cent. of the wagons are at the present time idle. As most undertakings have wholly insufficient accommodation of their own, the charge to be made by the Great Western Company will inflict a heavy addition to their already substantial financial burdens. The probability is that most colliery companies have siding accommodation of their own capable of holding only a quarter of the wagons owned by them. The action of the company is being strongly opposed, and it is pointed out that the charge is unjust, particularly in the case of loaded wagons, the movement of which, in view of the control exercised over coal supplies, is entirely in the hands of a Government Department.

LATER.

The Commercial Committee of the South Wales Coalowners' Association has decided to communicate with the Great Western Railway Company stating that the colliery companies cannot agree to pay any charge for storage, as it has always been the custom for colliery wagons to be stored on railway sidings free of charge. It is also pointed out that railway sidings were provided specially for storage purposes, and that during the stoppages in 1898, 1912 and 1921 wagons remained on railway sidings without any charge being made.

Steel Works Restart.

The Panteg Steel Works, belonging to Baldwins, Ltd., started work on Monday, after a long period of inactivity. About 1000 men are employed. A resumption was made possible by the assistance of supplies of German coal and steel.

Ship-repairing Contracts.

Mountstuart Dry Docks and Shearman's, Ltd., of Cardiff, Newport, &c., have recently secured two very useful ship-repairing contracts in open competition. The ss. Caithness, which sustained heavy bow damage as the result of collision with the ss. Amicus in the River Plate, will provide work for about three weeks, the amount of the contract being about £3500. The other order is that of the repair of the ss. Gaelic Prince, which not long ago collided with the ss. Trelawney, which latter vessel was sunk. The contract price has not yet been disclosed, but it is understood that there is about a month's good work on this steamer.

Tin-plate Works.

Four of the eight mills at the Cwmbwrla Tin-plate Works, Swansea, have restarted after a stoppage of six weeks. Work is to be shared between the men, who will work three days a week on two shifts.

CATALOGUES.

CROSSLEY BROTHERS, Ltd., Openshaw, Manchester.—Publication C108, illustrating and describing the new 2 and 3 brake horse-power totally enclosed paraffin engines.

VENESTA, Ltd., 1, Great Tower-street, E.C. 3.—Booklet describing the uses of "Plymax," which consists of plywood faced on one or both sides with thin sheet metal.

THE GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, W.C. 2.—Bulletin No. 14, dealing with the G.E.C. system of protection for generating and transmission plants.

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester.—Circular No. 1710/7, dealing with various types of apparatus specially manufactured to meet mining conditions.

CONTRACTS.

STERNS, Ltd., of 118, Cannon-street, London, E.C. 4, has received an order from the Victoria Falls and Transvaal Power Company, Ltd., for the supply of turbine oil.

THE GENERAL ELECTRIC COMPANY, Ltd., has received an order from H.M. Office of Works for the supply of Osram vacuum and gas-filled lamps for a period of twelve months.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., Ltd., have received an order to build twenty-five heavy goods locomotives and tenders for the Queensland Government Railways. These locomotives, which are to be of the Railways' C.1.7. 4-8-0 class, will be constructed at the Scotswood Works, Newcastle-on-Tyne, and are to be shipped to Brisbane fully erected and in running order.

YARROW water-tube boilers have been selected for all of the five vessels—two liners and five cargo steamers—ordered by Canadian Pacific Steamships, Ltd., for the Atlantic trade. Yarrow and Co., Ltd., have received the order for the complete designs for high-pressure boilers, superheaters, and air heaters for the two liners, which will be constructed under licence by the builders of the vessels. Messrs. Yarrows are themselves to supply the boilers and accessories for the cargo steamers. These boilers will be fitted with mechanical stokers supplied by Erith's Engineering Company, Ltd., London.

THE WOODALL-DUCKHAM VERTICAL RETORT AND OVEN CONSTRUCTION COMPANY (1920), Ltd., has received from the Gas Light and Coke Company of London an order for four waste heat boilers to work in conjunction with horizontal retorts in two of the retort houses at the Beckton Gasworks. These boilers will have a total gross steam-raising capacity of over 52,000 lb. of steam per hour at 160 lb. per square inch and 200 deg. Fah. added superheat. The installation is to be complete with all necessary equipment, including feed-water heaters, feed-water pumps, turbo-driven fans and superheaters.

THE LEIPZIG INTERNATIONAL INDUSTRIES FAIR.—The management of the Leipzig Fair has decided that this autumn the General Sample Fair as well as the Technical Fair shall take place from August 29th to September 4th.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 2 6	—
No. 1 Foundry	4 10 0 to 4 15 0	
No. 3 Foundry	4 5 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 1 0	4 1 0
No. 1	4 1 6	4 1 6
Cleveland—		
No. 1	4 12 6	4 13 0
Silicious Iron	4 12 6	4 13 0
No. 3 G.M.B.	4 10 0	4 10 6
No. 4 Foundry	4 9 0	4 9 6
No. 4 Forge	4 8 6	4 9 0
Mottled	4 8 0	4 8 6
White	4 8 0	4 8 6
Mid.lands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 5 0 to 3 10 0	
,, Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	(*None offered.*)	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	(*None offered.*)	
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lanes. and Cum.—		
Hematite Mixed Nos.	4 8 6 (*a*) / 4 12 0 (*b*) / 4 16 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 5 0	11 0 0
Best	—	—
N.E. Coast—		
Common Bars	11 5 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
Midlands—	(*Prices nominal.*)	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ½in. and up	7 17 6	7 0 0
Sections	7 7 6	6 5 0
Steel Sheets, under 3/16in. to ¼in.	11 0 0 to 12 0 0	
Sheets (Gal. Cor. 24 B.G.)	—	£17 5 0 to £18 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 0 0	—
Angles	7 10 0	—
Boiler Plates	11 10 0	—
Joists	7 10 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 10 10 0†	
Manchester—		
Bars (Round)	9 5 0	—
,, (Small Round)	11 0 0	—
Hoops (Baling)	11 0 0	11 0 0
,, (Soft Steel)	14 15 0	10 15 0
Plates	8 2 6	—
,, (Lanca. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	7 15 0 to 8 10 0	
Billets and Sheet Bars	6 2 6 to 6 7 6	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 0 0 to 17 10 0	
Angles	7 7 6 to 8 17 6	
Joists	7 7 6 to 8 17 6	
Tees	8 7 6 to 9 17 6	
Bridge and Tank Plates	7 17 6 to 8 15 0	
Boiler Plates	11 0 0 to 11 15 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	23/- to 25/-
Block Tin (cash)	297 15 0
,, (three months)	290 10 0
Copper (cash)	59 0 0
,, (three months)	59 15 0
Spanish Lead (cash)	33 0 0
,, (three months)	33 15 9
Spelter (cash)	34 8 3
,, (three months)	34 12 6
Manchester—	
Copper, Best Selected Ingots	66 15 0
,, Electrolytic	67 17 6
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
,, Condenser	0 1 2½
Lead, English	34 15 0
,, Foreign	32 15 0
Spelter	34 15 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, 8 p.c. to 10 p.c. ,,	£20 15 0	6/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£38 10 0	12/6
,, ,, 1 p.c. ,,	£44 10 0	15/-
,, ,, 0·70 p.c. carbon	£54 10 0	17/6
,, ,, carbon free	1/5½d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 5 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 10 0 scale 6/- per unit	
,, Vanadium	15/- per lb.	
,, Molybdenum	6/- per lb.	
,, Titanium (carbon free)	0/11 per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

	Inland. (*Nominal: none on offer.*)	Export.
SCOTLAND. (*Prices nominal.*)		
Lanarkshire—		
(f.o.b. Glasgow)—Steam		15/9
,, ,, Ell		16/6
,, ,, Splint		16/6 to 17/-
,, ,, Trebles		15/9
,, ,, Doubles		14/- to 14/6
,, ,, Singles		13/9
Ayrshire—		
(f.o.b. Ports)—Steam		16/9
,, Jewel		17/- to 17/6
,, ,, Trebles		17/-
Fifeshire—		
(f.o.b. Methil or Burntisland)—Steam		12/6 to 14/9
Screened Navigation		21/-
Trebles		14/- to 15/-
Doubles		14/-
Singles		13/- to 13/6
Lothians		
(f.o.b. Leith)—Best Steam		14/- to 14/3
Secondary Steam		13/6
Trebles		14/6 to 14/9
Doubles		13/6
Singles		13/6
ENGLAND.		
(8) N.W. Coast—		
Steams		*No quotation*
Household		,, ,,
Coke		,, ,,
Northumberland—		
Best Steams		16/-
Second Steams		14/6 to 15/-
Steam Smalls		8/- to 8/6
Unscreened		13/- to 13/6
Household		20/- to 22/-
Durham—		
Best Gas		18/6 to 19/-
Second		15/- to 15/6
Household		20/- to 22/-
Foundry Coke		18/- to 20/-
Sheffield	Inland. (*Nominal: none on offer.*)	
Best Hand-picked Branch	31/- to 34/-	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	26/- to 28/-	—
,, ,, House	24/- to 25/-	—
,, ,, Large Nuts	17/- to 20/-	—
,, ,, Small	12/6 to 14/-	—
Yorkshire Hards	17/- to 19/6	—
Derbyshire Hards	16/- to 19/-	—
Rough Slacks	10/- to 12/6	—
Nutty Slacks	7/6 to 9/-	—
Smalls	3/6 to 6/-	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o.b.	16/- to 17/
Cardiff—	(9) SOUTH WALES.	
Steam Coals:	(*All prices nominal.*)	
Best Smokeless Large		26/- to 27/-
Second ,, ,,		24/6 to 25/6
Best Dry Large		24/- to 25/-
Ordinary Dry Large		21/- to 22/-
Best Black Vein Large		25/6 to 26/-
Western Valley Large		24/6 to 25/-
Best Eastern Valley Large		24/- to 25/-
Ordinary ,, ,,		23/6 to 24/-
Best Steam Smalls		17/- to 18/-
Ordinary ,,		16/- to 17/-
Washed Nuts		19/- to 20/-
No. 3 Rhondda Large		26/6 to 27/-
,, ,, Smalls		18/- to 18/6
No. 2 ,, Large		24/- to 25/-
,, ,, Through		20/- to 21/-
,, ,, Smalls		15/- to 16/-
Foundry Coke (export)		40/- to 50/-
Furnace Coke (export)		25/- to 30/-
Patent Fuel		42/6 to 45/-
Pitwood (ex ship)		26/6 to 27/6
Swansea—		
Anthracite Coals:		
Best Big Vein Large		39/- to 40/-
Seconds		32/6 to 35/-
Red Vein		27/- to 29/-
Machine-made Cobbles		47/6 to 50/-
Nuts		47/6 to 50/-
Beans		42/6 to 44/-
Peas		23/- to 25/-
Breaker Duff		7/6 to 8/-
Rubbly Culm		12/6 to 13/6
Steam Coals:		
Large		22/6 to 24/6
Seconds		20/- to 22/-
Smalls		11/- to 15/-
Cargo Through		16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. †(9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Steel Union.

THE Luxemburg steel producers have signed an agreement not to sell steel in Germany at below the prices of the Stahlwerksverband. As similar undertakings have been entered into by the Saar and Lorraine steel makers, there is no longer any obstacle to the constitution of the International Steel Union. It is believed, therefore, that all details will be finally settled at the forthcoming meeting at Dusseldorf, even if the agreement is not actually signed, and in any case it is fairly certain that the Union will come into operation at an early date. It covers all the steel products of the Stahlwerksverband, including merchant bars and sections, thick sheets and plates, hoops and rods. A similar union has already been constituted amongst the tube makers in France, Germany, Luxemburg and Belgium. It is hoped to extend considerably the scope of the Steel Union by securing the adhesion of other producing countries, and particularly Great Britain, for the conditions under which the steel industry is carried on are so deplorable that nothing but an organisation can save it from the disastrous effects of price cutting in foreign markets. This agreement amongst continental steel makers has also awakened a more confident feeling regarding the successful carrying through of negotiations for improving commercial conditions in Europe. The signing of a temporary commercial arrangement between France and Germany, on the understanding that the negotiations for a permanent treaty are to be resumed almost immediately, shows that both countries are feeling the effects of the present policy of exclusion which is practised nearly all over the Continent. The arrangement is limited to six months, and it is also restricted to certain categories of goods.

The Dockers' Strike.

The strike of dockers at Dunkirk has now lasted more than six weeks. It cannot be terminated except by the defeat of the men, because the struggle involves a principle which, if not upheld, will mean the utter ruin of the port. The men refused to allow employers to take advantage of their modern equipment. Soon after the Armistice, Dunkirk expected that the provinces of Alsace and Lorraine would readily abandon the Rhine as a transport route to Antwerp and Rotterdam and avail themselves of the facilities offered by the French port. Considerable sums of money were spent by the Dunkirk Chamber of Commerce upon the purchase and installation of cranes and other plant for loading and unloading ships until it became the best equipped port in the country. This expenditure seemed fully justified by the expected traffic from Alsace-Lorraine as well as from the great industrial centres in the North, which were increasing considerably their pre-war production. The Nord Railway Company offered specially reduced freights from Alsace-Lorraine, and representatives from the provinces visited Dunkirk to inspect the works which had been carried out for their special benefit. The advantages offered, however, failed to induce them to divert their traffic, which is still being sent to the Belgian and Dutch ports. The outlook therefore has become very serious for Dunkirk, which can only hope to recover its former prosperity by utilising its remarkably complete labour-saving machinery. The dockers' union is opposed to that being done, and insists on employment being found for the men who are displaced by machines. Consequently, it often happened that a number of men looked on while the elevating and other appliances were doing their work. At the same time the union was constantly striking for higher wages, which had to be paid to avoid a stoppage of work in times of special activity. Employers are determined to put an end to this state of things. They declare that the men will only be allowed to return to work when they recognise the right of the dock authorities to employ whom they please.

Railway Amalgamation.

The Paris-Orleans Railway Company has issued a statement to the effect that, in view of the opposition raised against the amalgamation of that company with the Midi Railway, it has been decided to abandon the original plan and to seek some other means of centralising the management of the two companies and thereby securing considerable economies. The objections came entirely from the Paris-Orleans users, who feared that the placing of both systems under the management of Monsieur Paul, the general manager of the Midi line, would be detrimental to their interests. Nothing, of course, can be said against the professional value of Monsieur Paul, whose management of the Midi line leaves no doubt about his fitness to take charge of both systems, but the Orleans users fear that the change might involve political interferences that might favour the Midi users at their expense.

Russian Trade.

During the many months that the Soviet commercial and financial delegation was in Paris negotiating with the French Treasury for a settlement of the various questions outstanding between the two countries, an active propaganda was carried on in favour of a development of trade relations with Russia. Encouraged by the promises of the Soviet representatives, arrangements were made for the holding of an exhibition of French products, which was to have been opened in Moscow last month. A considerable number of firms prepared exhibits, but meanwhile the Soviet delegation failed to accomplish its mission and left Paris, and when the exhibits were ready to be sent off the Soviet refused to grant licences for their importation into the country. This violation of an official undertaking to accord every facility for the holding of a French exhibition in Moscow has entailed so much loss to manufacturers that the organisers are determined to take proceedings against the Russian authorities to recover damages.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

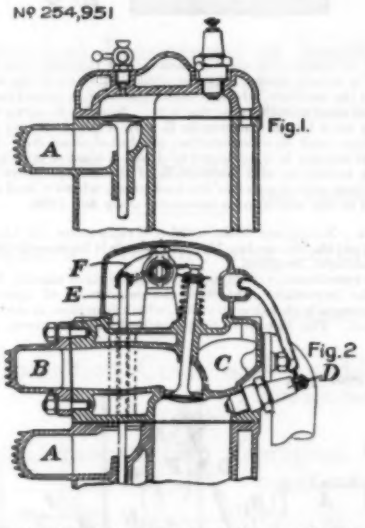
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

254,951. November 16th, 1925.—CONVERSION TO OVERHEAD VALVES, G. E. Silvani, 10, Via Gustavo Modena, Milan, Italy.

This invention is concerned with the conversion of engines having ordinary side valves, such, for instance, as the F.I.A.T. engine, to overhead valves. In the drawings Fig. 1 shows the normal arrangement and Fig. 2 the conversion. It will be noticed that the original exhaust A is replaced by a new one B. The

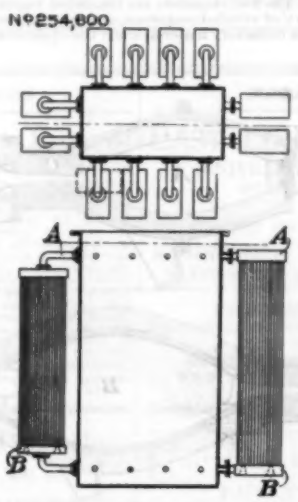


induction chamber is shown at C and the sparking plug at D. The tappet rods are extended—see E—to work rockers F for operating the valves. The valves are set at an angle, as shown, so that all the upper ends of the stems are in a line, while the valves lie alternately towards opposite sides of the cylinder diameter. In the event of the valve stem breaking the valve will drop until it fouls the side of the cylinder and will then be checked, with, it is claimed, a minimum of damage to the engine.—*July 15th*, 1926.

TRANSFORMERS AND CONVERTERS.

254,600. December 11th, 1925.—IMPROVEMENTS IN COOLING RADIATORS FOR ELECTRIC TRANSFORMER TANKS AND LIKE USES, St. George's Engineers, Ltd., of Ordsall-lane, Trafford Bridge, Salford, Lancaster, Herbert Purslow and John Anderson, all of the same address.

According to this invention the top and bottom headers or boxes A B of transformer radiators are constructed of separate

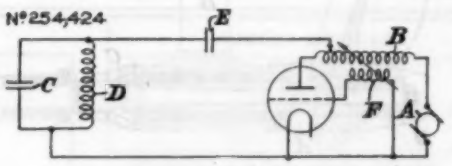


rectangular or other flat plates or sheets of metal, which are welded together along their edges to form rectangular or triangular oil or liquid light boxes, one plate in each box being drilled or punched to receive the tubes and another plate with a hole provided with a pad or flange to which the branch connection is fixed.—*July 8th*, 1926.

TELEGRAPHS AND TELEPHONES.

254,424. April 18th, 1925.—IMPROVEMENTS IN OR RELATING TO ALTERNATING-CURRENT GENERATORS EMPLOYING THERMIONIC VALVES, Cyril Reginald Burch, of 25, Moreton-avenue, Stretford, Manchester; Neville Ryland Davis, of 11, Darley-road, Seymour-grove, Manchester; and Metropolitan-Vickers Electrical Company, Ltd., of 4, Central-buildings, Westminster.

This invention relates to alternating-current generators, employing one or more thermionic valves, and particularly to that type of generator in which the supply of energy is fed to the anode of the valve through a choke coil. The anode oscillatory circuit is connected to a point upon the high-frequency choke coil and preferably the connection is adjustable so that it may be made at any point between the ends of the coil. The anode connection may also be made at a point between the ends of the choke coil. In some cases an additional choke coil may be connected in series with a blocking condenser directly between the anode and cathode of the valve, thus shunting the oscillatory circuit and the point of connection of the coil to the anode and/or the oscillatory circuit may be arranged to be adjustable. In the diagram a thermionic valve has its anode circuit supplied with current from the generator A, through the choke coil B. The oscillatory circuit of the system consists of the condenser C connected with an inductance D. The lower end of the oscil-

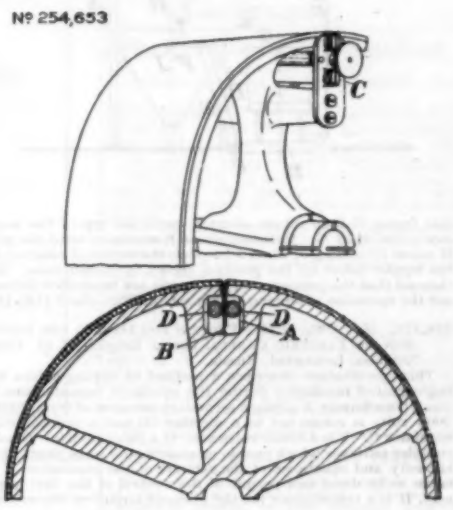


latory circuit is connected to the cathode of the valve, whilst the upper end of the oscillatory circuit is connected through a blocking condenser E to some point of the high-frequency choke coil B. The effective resistance of the circuit C D and any load coupled thereto referred to the valve is a minimum or the loading of the valve is a maximum when the circuit C D is connected to the anode of the valve. When the connection of the circuit C D is made to a point on the choke coil B, the effective resistance of the circuit C D is increased as the number of turns of the inductance B between the anode of the valve and the connection to the circuit C D is increased. The choke coil B acts in a similar manner to a step-down auto-transformer. In order that the system shall act as a generator of electrical oscillations, the grid of the valve is connected through an inductance F to the cathode. There are three other illustrations.—*July 8th*, 1926.

MEASURING AND TESTING INSTRUMENTS.

254,653. March 24th, 1926.—MEANS FOR ATTACHING SHEETS ON INDICATOR DRUMS, W. J. Riley and W. J. Riley, the younger, Yote Works, Four Oaks, Sutton Coldfield, Warwickshire.

This device is intended for stretching and attaching the paper or card used on indicator drums or recorders. A longitudinal recess A is provided in the surface of the drum, and in it is fixed a plate B, supported by brackets at the ends of the drum, one of which is shown at C. On either side of this plate there are longitudinal spindles D D, which are covered with rubber sleeves and can be turned by means of knurled heads to draw the ends

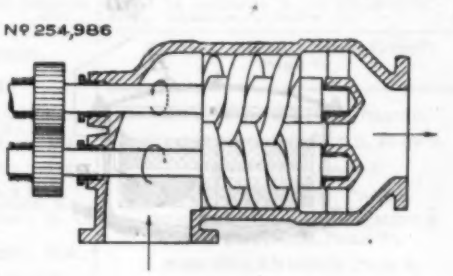


of the paper taut round the drum into the recess. Flats are cut on the sides of the spindles to provide clearance for the initial insertion of the paper.—*July 8th*, 1926.

PUMPING AND BLOWING MACHINERY.

254,986. January 2nd, 1926.—SCREW PUMPS, A. J. Mollinger, 143, Kleverlaan, Haarlem, Holland.

This invention relates to that form of pump in which two screws of opposite hand are rotated in engagement in opposite directions and thus force the liquid through the surrounding casing. The feature concerned is the formation of the screw threads in such a manner that they will make a water-tight joint, one with the other, without slackness. The screws are



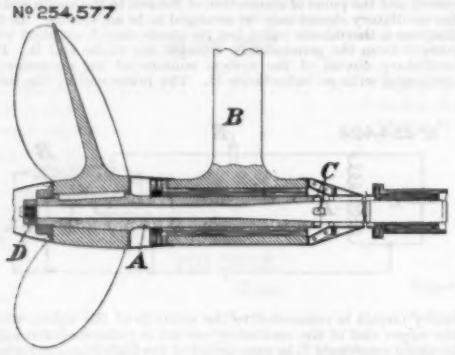
described as having each symmetrically shaped flanks, the surface of each flank being generated by a line, the mid-portion of which may be straight, but which is curved convexly at the outside and concavely at the inside of the screw, whereas the imaginary line connecting the points where the said generating line meets the outside and the inside cylindrical surfaces of the screw makes an angle with the shaft centre line between 30 deg. and 75 deg.—*July 15th*, 1926.

SHIPS AND BOATS.

254,577. October 22nd, 1925.—Propellers, H. E. Yarrow, Scotstoun, near Glasgow.

The object of this invention is to obviate the necessity for removing the tail shaft for renewal or repair on account of having been cut by grit in the water. In effect, it consists in mounting

Nº 254,577



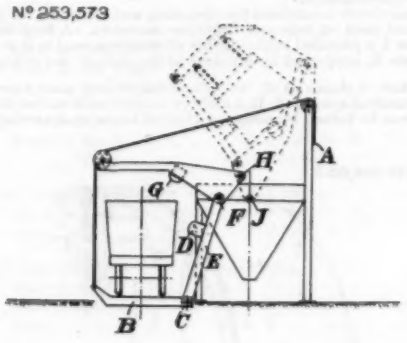
the propeller on a sleeve A, which forms the rubbing surface working in the bearing in the propeller bracket B, and fixing this sleeve on the tail shaft by means of a taper seating, the driving lugs C and the nut D. If the bearing sleeve becomes worn, it can be easily removed and replaced without disturbing the tail shaft.—*July 8th*, 1926.

MISCELLANEOUS.

253,573. March 11th, 1925.—Wagon Tipplers, B. E. Ellson, 57, Queen's-road, Richmond, Surrey.

The object of the inventor has been to provide a tippler the hopper of which is wholly above the ground level. When the hoisting rope A is pulled, the table B first rotates about the pivot C until the wagon side meets the chock D. The table and

Nº 253,573

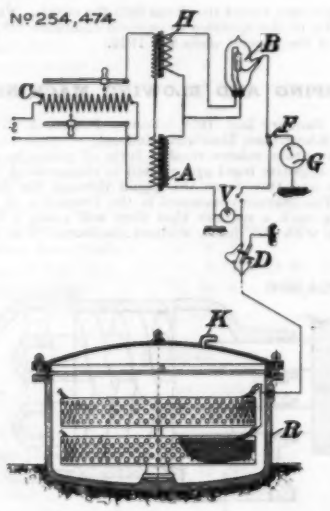


side frame E then rotate about F until the top of the wagon meets the chock G. Rotation about F continues until the pivot H meets its seating J, when J becomes the centre of rotation and the tippler takes up the position shown in dotted lines. It is claimed that the pressures on the wagon are controlled throughout the operation of tipping within safe limits.—*June 11th*, 1926.

254,474. May 29th, 1925.—Process for Drying the Insulation of Electric Cables, Sergei Bragin, of 17, Grosse Zelenina, Leningrad, Russia.

This specification describes a method of drying cables with impregnated insulation during the course of manufacture. A small transformer A giving a secondary pressure of from 2000 to 5000 volts is connected to a rectifier B, and a potentiometer regulator C. V is a static voltmeter, G a galvanometer, D and F tumbler switches which enable measurements to be made of the capacity and resistance of the strands of the insulation of the cable to be dried and permit of the control of the drying process, H is a transformer for the filament circuit of the rectifier.

Nº 254,474

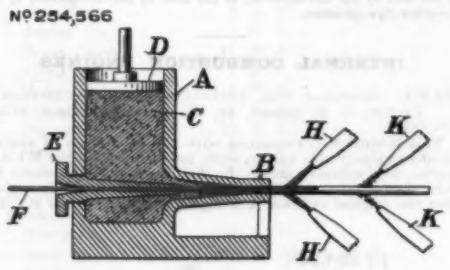


Current is supplied to the cable, which is placed in the receptacle R. The tumbler switch D makes it possible to supply current to one core of the cable or to all three of them. The walls of the receptacle R are usually heated by steam, and the pipe K places the interior of the receptacle in communication with a vacuum pump. With the aid of the electrical apparatus described, a certain positive potential is given to the cable cores with respect to earth, and the removal of moisture from the paper, cotton or other insulation of the cable is effected by the simultaneous action of heat, vacuum and electrification. The process is claimed considerably to shorten the period of the drying process.—*July 8th*, 1926.

254,566. September 30th, 1925.—Improvements in or appertaining to Electric Cables and in the Process for Making same, *Western Electric Company, Ltd., of Connaught House, Aldwych, London, W.C. 2.*

The object of the inventors is to provide a cable that is cheap to manufacture and efficient in operation. The apparatus for making the cable is shown in the drawing. A is a metal container with a nozzle B. A mixture of pulp and oil C is introduced into the container and pressure is applied to it by means of a piston D which forces the mixture through the nozzle B. A removable

Nº 254,566

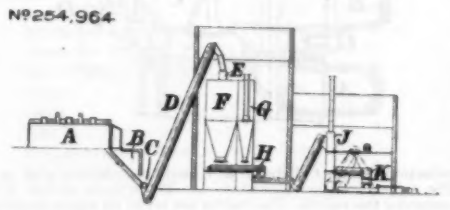


plug E is inserted in the container, and through this plug the wire F is slowly drawn. As the wire passes out of the nozzle B, some of the mixture, which is under pressure, is forced out with it and will tend to adhere to the wire. Nozzles H spray the pulp coating as it leaves the nozzle B with a quick-drying cohesive substance, such as ether-shellac, alcohol-shellac, &c. A second series of nozzles K is arranged to direct a blast of cold air on the coating to dry it, and thereby hold the soft pulpous material in position until it reaches the lead press, where a lead sheath is applied in the well-known manner.—*July 8th*, 1926.

254,964. November 28th, 1925.—Utilisation of Lignite as Fuel, H. Debauche, 75, Chaussée de Charleroi à Gilly, near Charleroi, Belgium.

This specification is vague in its descriptive matter, but deals with the important subject of the conversion of lignite into a fuel having a high calorific value, which function, it is claimed, is achieved. The lignite is first distilled in coke ovens A and is

Nº 254,964



quenched in the hopper B by means of steam. It is taken by the conveyor C, still hot, to the elevator D and screened to various sizes by the conveyor E. It is collected in hoppers F and the various grades are mixed separately with pitch from hoppers G on a conveyor H. The mixture is elevated to the top of a "malaxator" J and briquetted in a press K. In some cases the product is subsequently re-distilled to drive off some of the volatile constituents.—*July 15th*, 1926.

254,966. December 1st, 1925.—Production of Motive Fluid Under Pressure for Power Purposes, *E. C. R. Marks, 57, Lincoln's Inn-fields, London, W.C. 2.*

This invention concerns the combustion chambers for internal combustion turbines and similar machines. The apparatus comprises a combustion chamber A and an expansion chamber B which has approximately twice the cubic capacity of A. They are both of ovate form with a length of from 2½ to 3 times their major diameters. The two chambers are connected together by a Venturi passage C of vitrified soapstone, and the combustion chamber is lined with refractory material while the expansion chamber is

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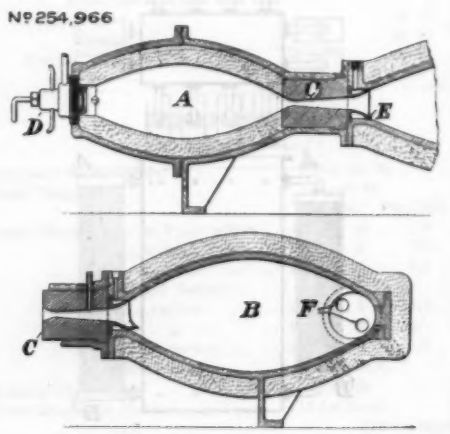

lagged. At one end of the combustion chamber there is an oil burner D and at the outlet E from the Venturi passage there is introduced a supply of compressed air. The result is a large volume of gases at a comparatively low pressure, which is taken away at F for utilisation. Attention is drawn to the fact that the elongated ovate form of the chamber having a definite size in relation to the required consumption of oil and air is an important feature of the invention, in that it ensures that the products of combustion progress, as formed, toward the exit and do not circulate backward toward the burner, where they, being inert, would interfere with the combustion.—*July 15th*, 1926.

254,991. February 13th, 1926.—Centrifuging Machines, Construction Française d'Appareils de Laiterie, Le Rond Point, Saint Etienne, Department of Loire, France.

This invention is concerned with the connection between the basket spindle of a centrifuging machine and its driving motor in such a manner that lack of balance in the basket will not transmit vibrations to the motor. The arrangement comprises a hollow shaft A on which is keyed the rotor B rotating within a stator enclosed within a casing C. The shaft A is accurately centred at its upper end in ball bearings D and at its lower rests

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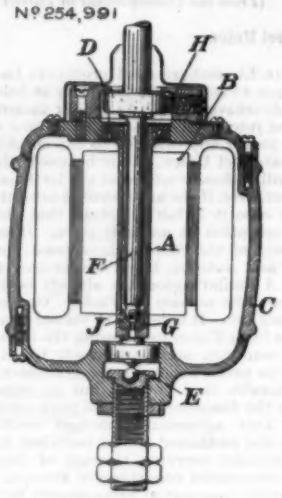

in a footstep bearing E adjustable in height. The shaft or spindle F carrying the centrifuge basket is arranged inside the hollow shaft A, bearing at its lower end in a bearing G in the form of a socket formed in the hollow shaft. The lower rounded end of the spindle is slotted and affixed to the socket G by a pin J which only transmits a rotational movement to the spindle—that is to say, that of the hollow shaft A. The spindle F is guided and supported part way along its length by a spring support H. On starting up the forces tending to unbalance the system produce oscillations which are damped by the spring support H so that the machine can resume its equilibrium position.—*July 15th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

FRIDAY AND SATURDAY, AUGUST 27TH AND 28TH.

Iron and Steel Institute.—Autumn meeting at Stockholm. For programme see page 125.

WEDNESDAY TO SATURDAY, SEPTEMBER 1ST TO 4TH.

Institute of Metals.—Autumn meeting at Liége. For programme, see pages 45 and 181.

TUESDAY TO THURSDAY, SEPTEMBER 14TH TO 16TH.

Institution of Public Lighting Engineers.—Annual meeting and Conference at Newcastle-upon-Tyne.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Rd. Johnson, Clapham and Morris, Ltd., have been appointed sole agents in the North of England and North Wales for Armco ingot iron sheets.

Thermit Ltd. has transferred its works from Church-road, Battersea, to Angel-road, Edmonton, London, N. 18. Telephone, Tottenham 3130; telegrams, Fulmen, Phone, London.

Mr. Henry Pels asks us to state that he has moved his office from 40, Great Marlborough-street, London, W. 1, to 32–38, Osnaburgh-street (near Great Portland-street Underground Station), London, N.W. 1. New telephone number, Museum 8880. The telegraphic address remains "Rypelsneh, London."

The Empire Forestry Association asks us to state that its offices have been transferred from the Imperial Institute to 22, Grosvenor-gardens, London, S.W.; telephone, Victoria 7690. It is requested that all inquiries and communications respecting the Association or the *Empire Forestry Journal* should in future be sent to the latter address.

Mr. S. McPherson, general secretary of the Institution of Quarry Managers, 160, Edmund-street, Birmingham, at the request of a number of brickworks owners and managers, is to form an Institution of Brickworks Managers "for the discussion of technical and geological questions relating to brickmaking and other matters pertaining to the control of the brickworks and the welfare of members."

LAUNCHES AND TRIAL TRIPS.

Storsten, motor ship; built by Barclay, Curle and Co., Ltd.; to the order of Tönsberg Rederi A/S, of Norway; dimensions, 400ft. by 52ft. 9in. by 29ft. 3in.; 5300 gross tonnage. Engines, sliding cylinder, two-stroke cycle, double-acting Diesel; constructed by the builders; trial trip, July 23rd.

Mernoo, cargo steamer; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of the Melbourne Steamship Company, Ltd.; dimensions, 296ft. by 42½ft. beam; to carry 3600 tons deadweight. Engines, triple-expansion; constructed by George Clark, Ltd., of Sunderland; launch, July 26th.

Lionel, motor ship; built by A. P. Moller, Odense Steel Shipyard, Denmark, to the order of the Steamship Company "Ostlandet," Oslo; to carry 8700 tons deadweight on a draught of 26ft. 6in. Engines, twin-screw, six-cylinder Diesel; constructed by Burmeister and Wain; launch, July 27th.

Pass of Melfort; oil tanker; built by the Blythswood Shipbuilding Company, Ltd., to the order of the Bulk Oil Steamship Company, Ltd.; dimensions, 200ft. by 30ft. by 13ft. 7in. Engines, triple-expansion, 14in., 23in., 39in. diameter by 27in. stroke; constructed by J. G. Kincaid and Co., Ltd.; trial trip, August 9th.